Concrete

Vol. 27 Chicago, December, 1925 No. 6

Attractive Stucco That Is Permanent

Cement Stucco, Applied in New Way to Concrete, Block, or Frame, Affords Better Texture and Color Treatments in Addition to Sound Construction—How to Apply the Reinforcing—The Scratch Coat—The Browning Coat—Finish Coat—Obtaining Three Special Textures

With the new prepared Portland cement stucco, recently developed in California and soon to be available throughout the country, the plasterer can easily and cheaply deliver a job that is far in advance of anything that has hitherto been possible. New, pleasing, and unusual color and texture treatments have been reduced to a practical basis, so that the plasterer can apply the scratch and brown coats from job-mixed materials, and then apply the desired finish without departing in any way from standard practice. Yet new effects are obtained, and a better and more practical job is produced.

The type of stucco that is just coming into use can be utilized either on frame or masonry structures, and is not limited to use on small homes, but has already been used on a number of tall office buildings.

On frame construction, the specifications must call for the right sort of construction underneath the stucco, as this covering is said to be quite permanent. Tight sheathing is nailed on the studs, and then a layer of roofers' felt is secured thereto, well lapped, and made entirely weathertight. The wall is then ready for the reinforcement.

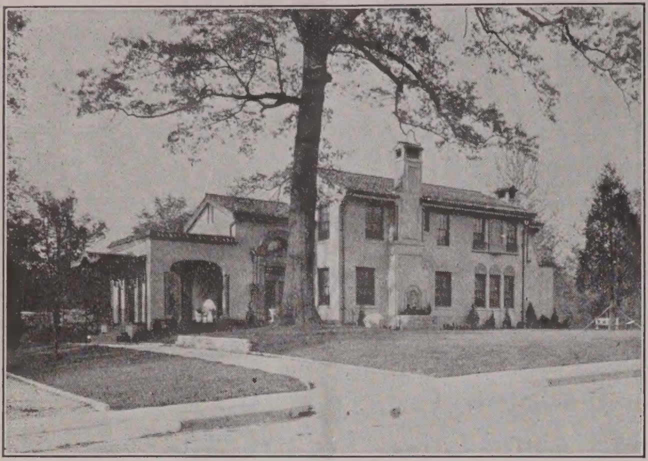
The Reinforcement

Specifications call for the use of expanded metal or a wire fabric, and special furring nails. The expanded metal, cut from sheets, should not be less than 20 gauge in thickness, and have openings not less than $\frac{3}{4}$ in. by 2 in., nor more than $1\frac{1}{2}$ in. by 4 in., and should weigh not less than 1.8 pounds per square yard. Wire fabric should be composed of wires not smaller than 18 gauge, used with openings not less than $\frac{3}{4}$ in. square, and wires not less than 14 gauge to be used with openings not greater than 2 in. square. The furring nails should be of the type having a metal chair on the nail that will give a proper furring distance of $\frac{3}{8}$ in. without extra trouble to the lather. A nail of this type, manufactured in Los Angeles, is shown here. It comes ready to use, and is driven as readily as an ordinary nail, but gives the proper furring automatically. These nails come in kegs, and sell for a price that is hardly higher than that prevailing for ordinary nails of the same size. The furring unit is clamped onto the point of the nail at the factory, and is held in place with sufficient pressure to discourage removal by the lather, but to make driving of the nail no harder than the driving of an ordinary wire nail. When in use, the lath is placed upon the furring unit, the nail driven so that the furring device slides along the nail, and grips the lath between the furring unit and the head of the nail. By this means the mesh is kept flat, and is at all points correctly furred out from the sheathing. Furring nails of this type should be spaced about 8 in. each way. The furring unit acts as a chair to keep the reinforcing sheet in its proper position, and as a clamp to hold it securely. This gives a continuous slab of stucco over the building, and not a series of separate units as are obtained when furring strips or rods are used. The use of a furring device is suggested of a type such as we illustrate. This type will not materially decrease the effective thickness of the slab of stucco, such as will be found to be the case when furring strips are used. On frame construction, the procedure is roughly as follows:

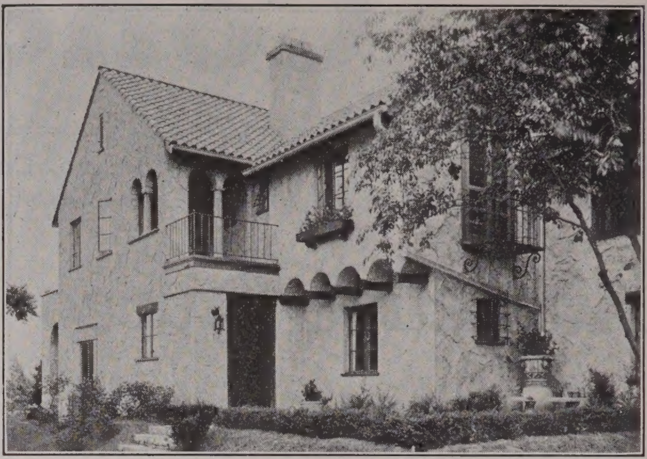
The studding and framing is run up according to the best practice, and a good grade of sheathing is laid tightly on the exterior of the studs. Then a 15 pound roofing felt is nailed onto the sheathing, with joints lapped 4 in., so as to make a perfectly weather-tight job. The lath is next nailed on with the self-furring nails, and the job is then ready for the stucco. The lath must be lapped 3 in. and tied securely, so that the metal can act as a unit as true reinforcement. Lath joints should be securely laced with 18 gauge annealed wire. Lath should be folded at least 4 in. around corners on sheathed construction and 16 in. on open construction. Corner beads should not be used.

The Scratch Coat

The 1:3 scratch coat is then run on until it just covers the surface of the mesh, the plasterer taking care to completely fill the space between the felt and the lath. Plenty of elbow grease and just ordinary skill is all that is required. The material is mixed right on the job, and there is nothing really new about this part of the work. Care, of course, must be taken to insure a good dense mortar that will provide an even suction and that will develop considerable strength. This coat will give the structure its first loading, and will bring the reinforcing in the center of the slab. Ten per cent hydrated lime is used.

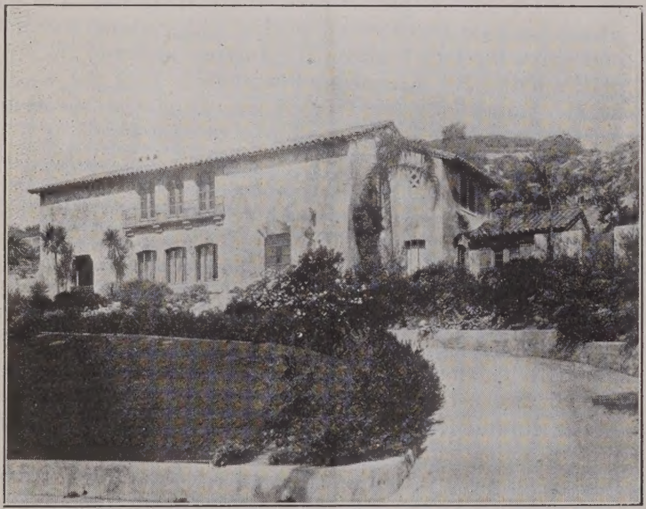


Residence of Leo Goodman, at Memphis, Tenn.
Mahan & Broadwell, Architects

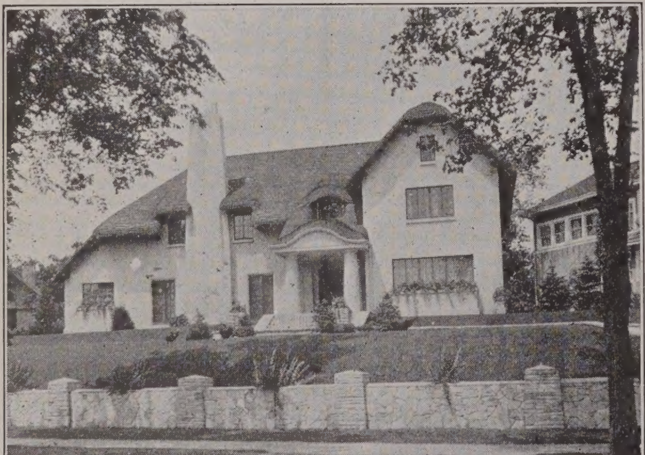


Residence of Wharton Clay, Winnetka, Ill.
Zimmerman, Saxe & Zimmerman, Architects

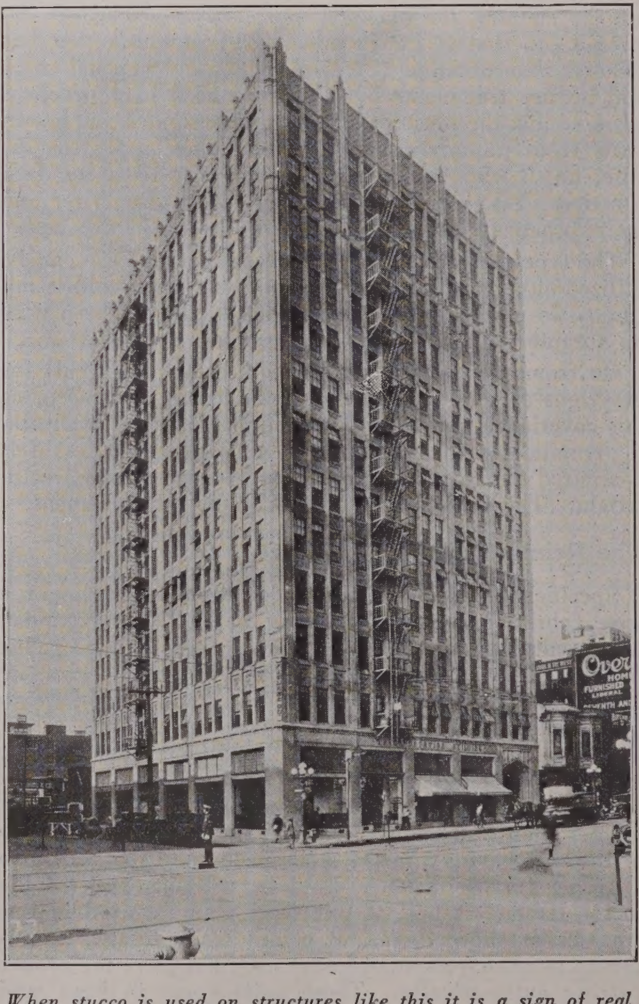
Stucco Buildings That Will Serve Well



Residence of Charles Seyler, Jr., Los Angeles, Calif. A fine example of the builder's art. Morgan, Walls & Clements, Architects



Residence at Minneapolis, Minn. A stucco home like this improves any neighborhood



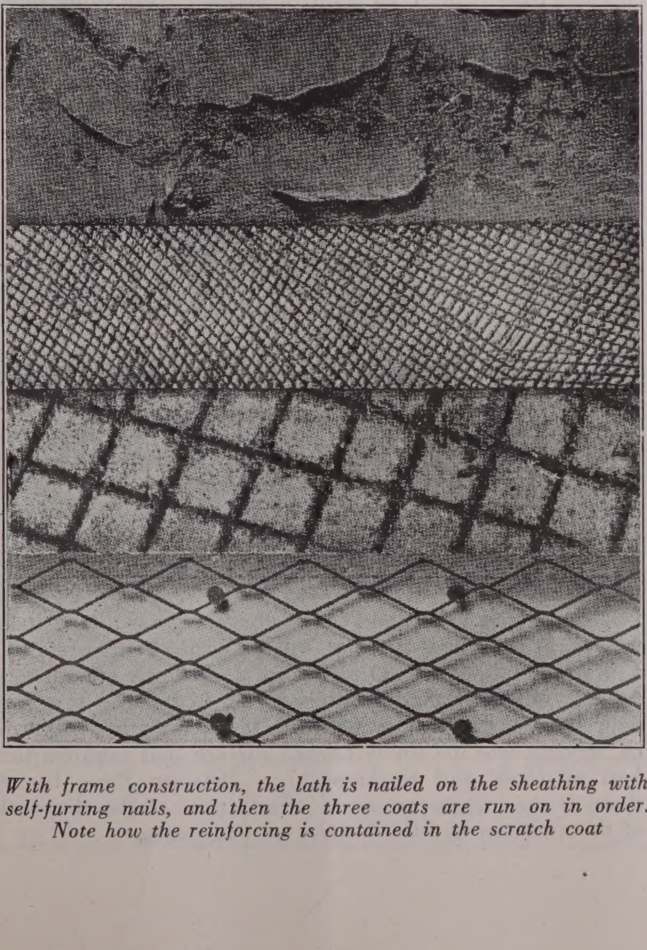
When stucco is used on structures like this it is a sign of real advance. Only the best of materials and construction can be specified, and temporary work is out of the question. Here is the Transportation Building, in Los Angeles, Calif., with the new stucco on the exterior

After the first coat has been cured for two days and then allowed to dry thoroughly, the half-inch browning coat, also containing 10 per cent hydrated lime, is run on. This coat must be firmly bonded to the scratch coat and must completely seal the scratch coat and any minute shrinkage cracks that have occurred. It must be extremely dense and true, and provide a good receptive base for the finish, with just the right amount of suction. The result must be an even suction that will preclude any spotty or uneven coloring of the finish, and, with the scratch coat, form a structural slab of the required strength, in the center of which will be the reinforcing mesh. The scratch coat draws the water from the browning coat and feeds it back slowly, in order that curing will be obtained under the best conditions. After this structural slab is perfectly cured and has obtained sufficient strength, the wall is ready for the finish coat. This coat should likewise be cured and sprinkled as was the scratch coat.

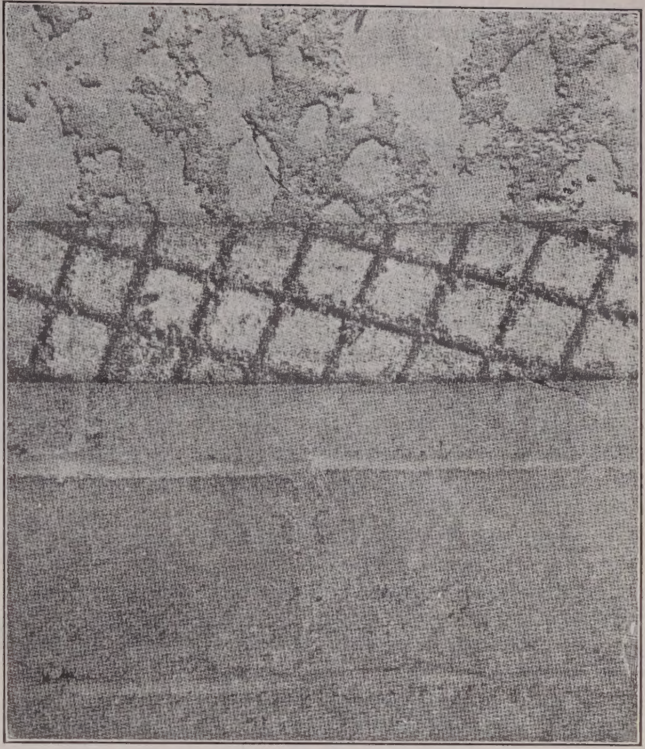
The Finish Coat

Here the art of the plasterer is called into full play. The manufacturer furnishes a 1:3 batch, sanded and colored, that is ready to apply upon mixing it with water. This finish stucco coat, which contains one part Portland cement, three parts sand, 10 per cent hydrated lime by weight of cement, and the right amount and shade of coloring matter, is usually run in tight to a thickness of 1/8 to 1/4 in., depending upon the texture. No rod or darby is permitted on the job, but the round pointed trowel, the sponge, the whisk broom, and the other common finishing tools are called into full play. It should be so applied as to be completely waterproof because of its density and the density of the structural coats, and at the same time must be given just the right texture and color blending that may be called for by the architect.

The first step in handling this finish coat is the preparation of the materials. By means of a mixer, or a mortar box and hoe, the dry sanded material is mixed with the correct, measured, quantity of water. Say three colors are to be run onto the wall. The proportionate quantities of each are first piled on the mortar board by the helper, convenient to the work. The plasterer than hawks up a quantity of each, building up in layers of the right proportions of each color, according to the effect desired. He then is able to cut down through the layers with his trowel and run the material onto the wall according to the requirements, thereby getting the mottled polychrome effect desired.



With frame construction, the lath is nailed on the sheathing with self-furring nails, and then the three coats are run on in order. Note how the reinforcing is contained in the scratch coat



Stucco is appropriately placed on concrete block walls in many cases. Here two or three coats are used as shown in this photograph

Color Blending

Another way is to first lay on one color, and then lay on another in spots, and then blending by means of the trowel or other tool, according to the texture to be secured. Details will appear later.

Frequently it is possible to secure unique effect by means of a color wash, which is applied after the finish coat has been run on. This is prepared by mixing cement and coloring matter into a bucket of water, and it is applied to the surface with a kalsomine brush. Often, after application, and after it has dried for about ten minutes, it can be blended by rubbing or brushing, gaining a variegated surface through which will show any other colors that may be underneath.

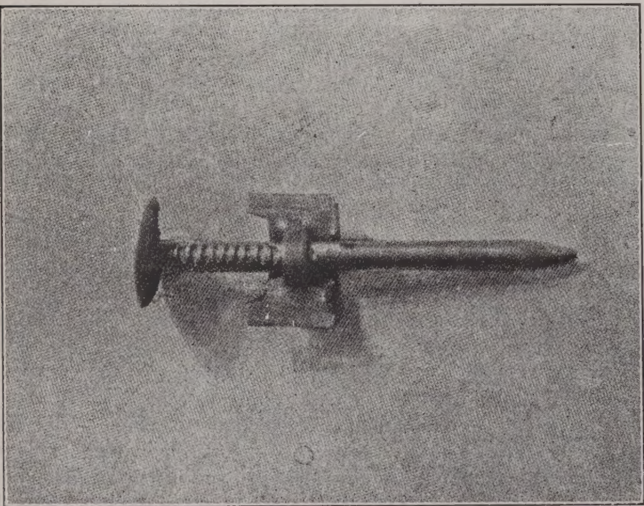
On masonry work the procedure is somewhat different. Here, where the stucco is placed directly upon the tile, the concrete, the brick, the stone, or other material, the matter of different suction may give a great deal of trouble unless the work is properly done. Wherever there is a change of material in the wall, there will be found a change in suction. This change in suction will necessarily create areas of different shading in the finished stucco, unless the construction is such that the effects of this uneven suction are neutralized. Care should first be taken that the wall that is to take the stucco is as uniform in suction as possible. No great variety of materials should be permitted. Then, after the wall is wetted down, the half inch scratch coat is run on as dense as possible, and then follow up with the browning coat. These two coats should not only seal the base materials, but must be of a quality of material and workmanship good enough to create an even suction over the entire surface. A good dense job will usually do the trick, since the browning coat will effectively seal any inequalities that may persist in the scratch coat due to different suction of the material in the joints. A brick wall often requires the use of expanded metal as a lath, since the brick itself may be glazed or painted.

With this type of construction, which is equally applicable to tall buildings and to small residences, and to interior decorative work as well as to exteriors, the very finest degrees of texture and of coloring can be secured, it is claimed, for no higher cost than $2 a square yard. It is permanent, and it is readily cleaned. Because of the water-tightness of the properly done job, the surface can easily be washed off whenever cleaning is required, and the steel is completely protected against corrosion, being completely embedded.

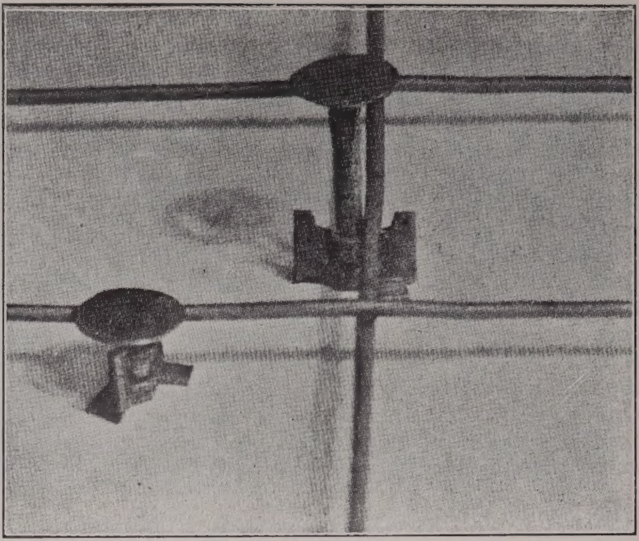
The fact that the coloring is placed in the finish coat in the factory makes it possible for the architect to order confidently from samples and know that the desired effect will be secured, even though he should not be on the job during its application to see that the colors are properly applied.

Any good plasterer, using the ordinary tools and methods of the trade, can secure a good workmanlike job without any particular amount of special instruction, since the practice has been worked out on the basis of regular and well known methods. It is merely a good step in advance, and has been proven successful on the west coast.

This system of stucco construction has been developed mainly through the efforts of O. A. Malone, of the California Stucco Products Company, Los Angeles, California, and that concern is now organizing plants for the manufacture of the finish coat in important construction centers throughout the country. The finish material, which is factory-made, thereby obtaining uniformity, stability, and economy, is provided in a wide range of colors. Only the best iron oxide-base colors are utilized, and are mixed in predetermined proportions with Portland cement hydrate, and sand. The material comes to the job in a dry condition, and is ready to use upon the addition of the required amount of water. The architect merely specifies the colors required, and the plasterer blends them according to the scheme of the architect, and applies them according to the effect desired.



A closeup of a recommended furring nail, with the furring device that gives good results at a low cost



Here we see one furring nail driven into place, firmly holding the mesh 3/8 in. from the sheathing. Another nail is being driven

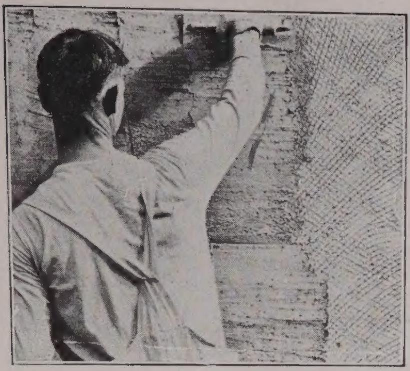
When desired, the plasterer can dispense with the prepared finish coat material and mix his own on the work. In such cases, the builder is advised to purchase a high grade of colors, and mix, in carefully controlled proportions, the materials in a good mixer. Hand mixing cannot be relied upon to give uniformity of coloring even under the best conditions.

Polychrome Effects

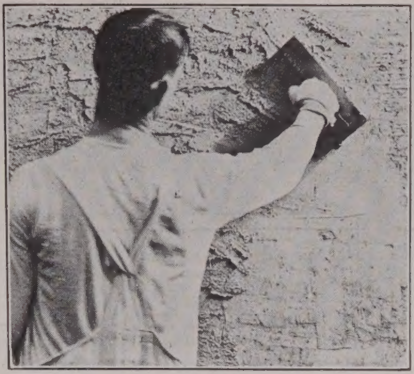
It has been stated before that interesting polychrome effects can be obtained by dabbing small bits of finish of different colors into the wall, when the finish coat is being applied. In detail, the plasterer first lays on his basic color, giving it the preliminary textural treatment required. He then takes up a bit of another colored material and dabs it on, then a bit of another color alongside, and so on until the wall is covered. He then, before he material has set, blends the mass by troweling down the high spots, and giving the wall its final texture. This, when using the round pointed trowel, is particularly effective on the Moorish treatment described on a following page, and on several others. This treatment can be followed up with a wash, if a general covering tone is desired. On interior decorative work, this sort of treatment may be used to afford walls and ceilings of the finest type, eliminating painting, and giving a permanent decorative scheme that only needs periodical cleaning to restore it to its original beauty.

In selecting any particular color and textural treatment a great deal of judgment must be used. The quieter colorings are more applicable to exteriors, and should conform to the architectural treatment of the structure and of the neighborhood, while the more ornate effects are particularly applicable to the interiors of theaters and similar structures. Generally speaking, the coarser textures are good on large structures and wall areas, while work of small expanse would require the texture whose scope is not as great.

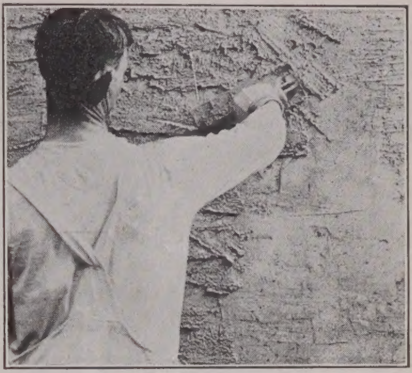
The cruder textures and color effects express the periods when craftsmen had nothing but the crudest sort of tools, while the highly finished and more delicate treatments are typical of more modern times. This thought may be expressed as the range between the old-daubed texture of Mexico, and the finely floated surface that requires the best of tools and workmanship. Between these limits there is an infinite series of effects now at the disposal of the architect and the builder at a low cost.



1. Apply a thin backing coat



2. Feather with the square trowel



3. Pinch off in all directions

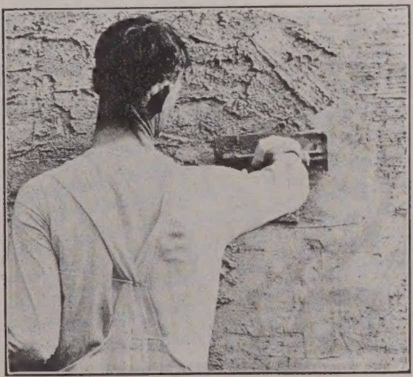
English Cottage

The shading of this texture is accomplished by feathering the material into minute, irregular weavings and surfaces with the edge of the trowel. The colors used are the softer effects of shaded browns, greys, and tans. The English cottage type of house, with its small windows, its steep and sharp gables, and its half-timbering, is just the place for this type of stucco finish.

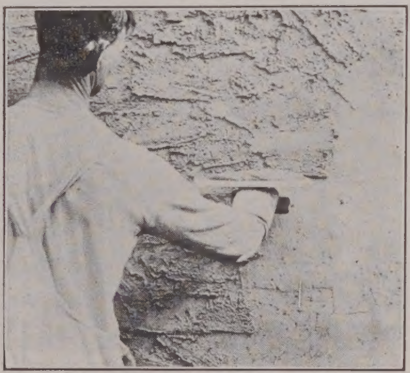
A very thin preliminary finish coat is first applied (Fig. 1) about ⅛ in. thick. This is left as applied, without further troweling, and forms a background coat as well as a plastic surface on which to work the final finish (Fig. 2).

A small amount of mortar—about a handful—is taken on the trowel (Fig. 5). The right size of this pat of mortar for any desired variation of this finish must be found by trial. Apply with short, twisting strokes, pinching off the pat of mortar onto the surface by having the trowel at an angle to wall as the mortar is placed (Figs. 2, 3, 4). The strokes should be made irregularly in all directions, regardless of location. The more these strokes are varied the more beautiful is the finished texture. Avoid having too many vertical or near-vertical strokes. By twisting the trowel as the pat of mortar is applied, slightly curved ridges will be formed (Fig. 3).

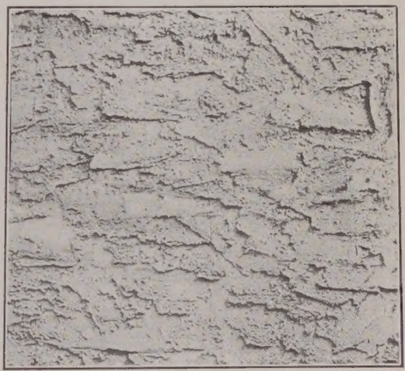
Many variations of this type of texture are possible by simply varying the amounts of mortar on the trowel, the directions and lengths of the strokes, the pressure and twisting motion given the trowel. Finer leaflike, more delicate textures are suitable for the smaller residences (Fig. 6), while the heavier applications made with more mortar and stronger strokes and applied in a freer fashion go with the larger type of house.



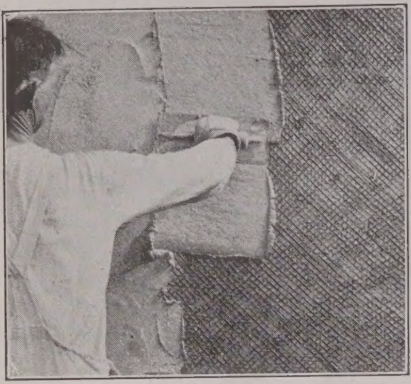
4. Twisting, feathering application



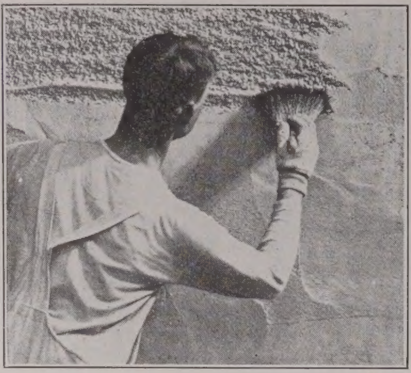
5. Dab on small dots of mortar



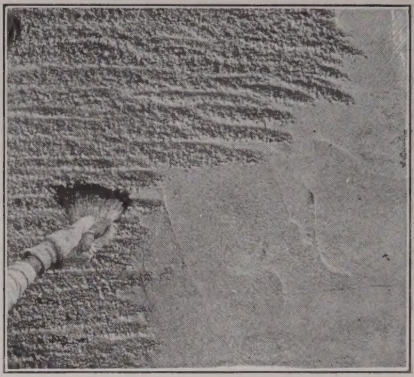
6. This is the resulting texture



1. Heavy strong application, like this



2. Irregular stippling, with the brush



3. Hold the brush at an angle, like this

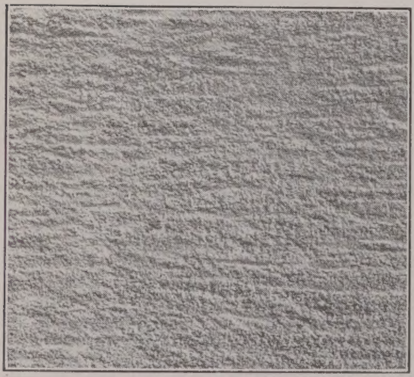
Italian Travertine

This texture is a representation in Portland cement stucco of the appearance of Travertine stone. While Italian in type, the texture may be formed to harmonize with the various architectural expressions, and many color effects may be used fittingly with this interesting finish.

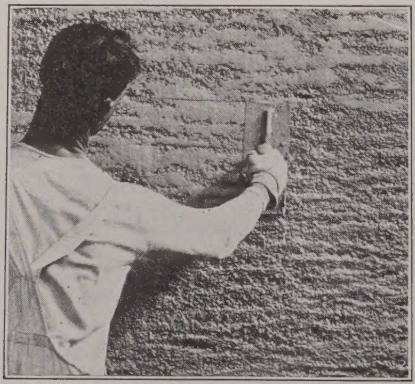
To create this texture successfully it is necessary that the finish coat of mortar have good plasticity, so the second coat should be well sprinkled just before the finish coat is applied, to "kill" part of the suction.

The finish coat is then applied about ⅜ in. thick and trowelled fairly smooth (Fig. 1). Then, using an ordidary whiskbroom, the fresh surface is stippled deeply (Figs. 2 and 3), pulling up an irregular texture on the surface of the mortar. This stippling should not be too regular in appearance, but might appear as in Fig. 4. In stippling, the whiskbroom should be held at an angle (Fig. 2) to the surface of the wall to produce the hillocks and hollows which, when troweled, form the veined markings of this texture.

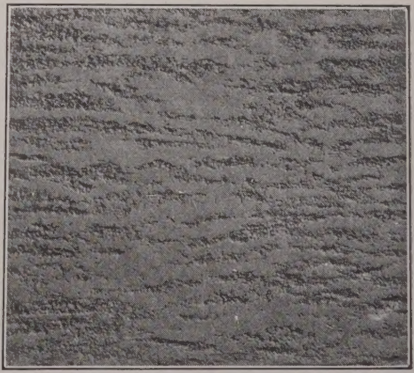
Using the trowel flat against the wall, smooth down with fairly strong pressure the higher portions of the coat to a plain surface (Fig. 5). No trowel marks should be left on the finished surface. The lower depressions made by stippling, however, remain in the finish and in combination with the trowelled areas create a very real effect of Travertine stone.



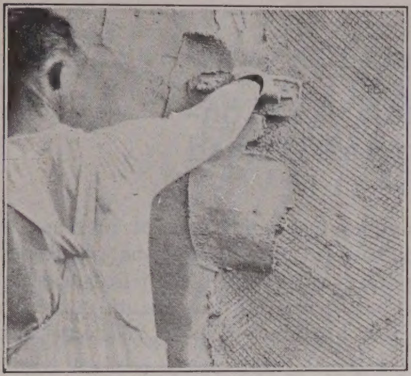
4. The stippled appearance, a scratched surface



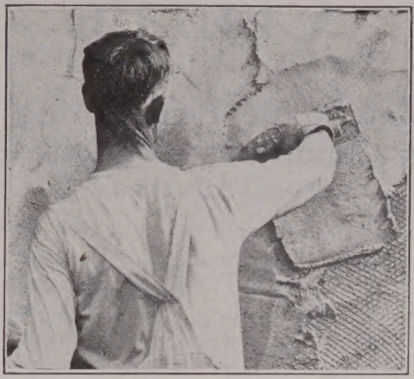
5. Trowel horizontally, hitting the high spots



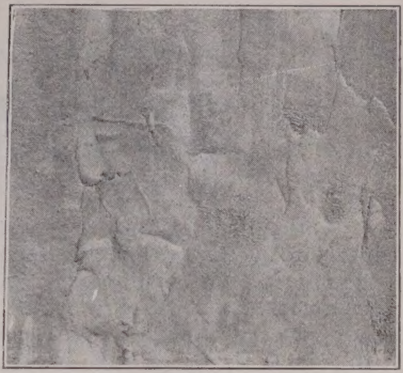
6. The result, with high spots smoothed down



1. *Placing the finish coat*



2. *A general vertical stroke*



3. *The preliminary appearance*

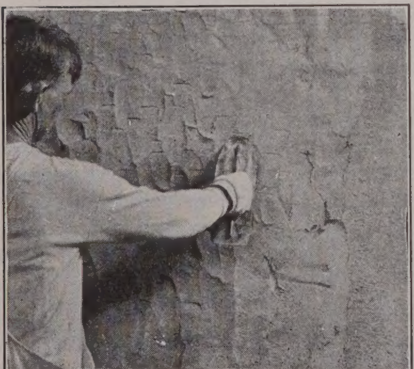
Moorish

This represents an extreme, both as to color and texture, and is an example of what can be done by irregular spotting. It corresponds to the use of ornament by the Moors, with a lighter tone of a primary color as shading.

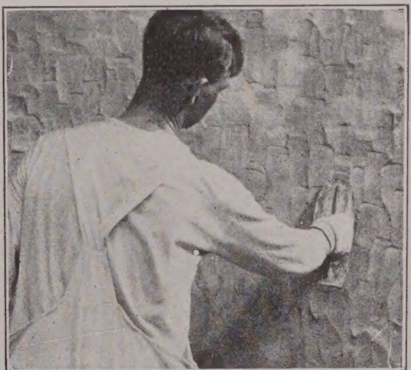
The finish coat in this texture is built up in the ordinary manner (Fig. 1) using the trowel with rounded corners for applying the mortar. Some variation is made in running the stroke of the trowel in different directions and in curves without making much attempt to smooth the coat as it is laid (Fig. 2).

Several methods of finishing this texture may be followed, one of which is shown here. This consists of manipulation of the round-pointed trowel in finishing the surface to create an effect like that which the stone mason produces in chipping or "pitching" a stone surface with his hammer and chisel. This leaves the surface as shown (Fig. 3) without trowel marks, but with slight ridges and hollows alternating with smoother spots throughout.

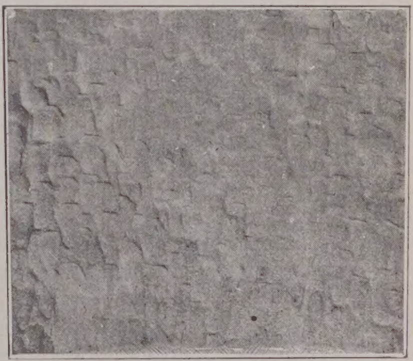
The resulting effect when properly viewed gives an idea of distant domes and minarets veiled over by a shadowing effect (Fig. 6). The texture will be found to be particularly attractive when sunlight strikes it at an angle, throwing shadows in the deeper spots and lights on the hills in the texture. A proper blending with dabs of several different colors, and often a wash on the high spots, will give a surface that is unusually effective for the Moorish type of house.



4. *Tooling with rounded-corner trowel*



5. *No definite design or lines*



6. *The final polychrome tooled surface*

Curing Concrete in a Semi-Arid Climate

Wet Earth Found to Be Best Curing Media for Concrete Under Dry Conditions—Various Chemicals Tested

In Bulletin 15 of the Structural Materials Research Laboratory, Lewis Institute, Chicago, the results of an investigation on this matter are reported by Harrison F. Gonnerman of that laboratory and C. L. McKesson, Materials Research Engineer, California Highway Commission.

The bulletin is a report on tests made at Sacramento, California, through the cooperation of the California Highway Commission and the Structural Materials Research Laboratory during the summer of 1924.

The curing experiments were carried out on 7 by 10 by 38-in. plain concrete beams made out-of-doors and cured in the open, after removal of forms at 16 to 24 hours, by the following methods:

(1) Covering with 2 in. earth, wet for 3, 7, 14, 26, and 88 days.
(2) Air curing, no surface treatment.
(3) Covering with asphaltic paper.
(4) Flake calcium chloride, 1½, 2, 2½, 3 and 5 lb. per sq. yd., sprinkled over the surface.
(5) Commercial sodium silicate (41° Baume), applied with a brush, undiluted, 1 to 1½ and 1 to 3 solutions.

The investigation included transverse tests and tests for surface hardness on 518 beams and compression tests on seventy-five 6 by 12 in. cylinders and prisms. The beams were tested at ages of 3 to 90 days with the cured surface in tension. The surface hardness of the concrete was measured by a ball-indentation test. The cylinders were cured in damp sand and tested at ages of 7 to 90 days. The prisms were cured with wet earth and calcium chloride and tested at 28 days.

The concrete was machine-mixed in the proportion of 1-2.2-3.0 by loose volume, and contained 6 sacks of cement per cubic yard. The consistency of the concrete was about that used in machine-finished concrete pavements (slump of about 1½ in.) and a few tests were made with wetter concrete. In 110 beams and 37 cylinders calcium chloride (2% weight of cement) was used as an admixture.

Based upon the data found as a result of the tests, the following conclusions were drawn, according to the bulletin:

(1) A curing method is efficient which maintains the moisture content of the concrete during the early stages of the hydration, about equal to the original mixing water. Wet-earth curing gave the best results of the methods used; this method apparently supplied moisture in sufficient quantity to replace losses due to evaporation and to absorption by subgrade. Curing methods which permitted high evaporation losses gave concrete of low strength.

(2) The tests showed that concrete cured under wet earth for 7 or 14 days was only slightly stronger than when cured under earth wet for 3 days. In view of this and of the small rate of increase in strength after the 14th day it may be concluded that with temperatures no lower than prevailed in these tests (70° F.) concrete pavements cured by covering with wet burlap for 16 to 24 hours and then with earth kept wet for 7 days, may safely be opened to traffic in 14 days.

(3) Curing with a surface application of flake calcium-chloride, 2½ lbs. per sq. yd., gave strength-ratios of from 88% at 7 days to 83% at 90 days; with less than this amount, and with 3 and 5 lbs., there was a slight reduction in strength.
When the calcium-chloride was washed off after 3 hours the strengths were reduced perceptibly; washing off calcium-chloride after 1 day gave essentially the same strengths as when left on the surface.
Surface hardness for calcium-chloride cured beams was considerably less than for beams cured with wet earth or with asphaltic paper.

(4) For beams molded and cured in concrete forms using calcium-chloride, 2½ lbs. per sq. yd., the strength-ratios ranged from 100% at 14 days to 89% at 90 days. The strengths in this case were about 12% higher than for beams molded in wood forms and cured in the standard manner with a similar amount of calcium-chloride, that is, on paper with the sides and ends of the beams banked with wet earth.

(5) Asphaltic paper curing gave average strength-ratios ranging from 92% at 7 days to 78% at 90 days; surface hardness was almost as high as for wet earth curing.

(6) Both air curing and sodium silicate curing showed low strength and surface hardness. The strength-ratios for these methods of curing ranged from about 77% at 7 days to 74% at 90 days.

(7) 2% calcium chloride used as an admixture in the concrete increased the flexural strength about 4% at 3 days for air and calcium-chloride curing and gave no increase for wet earth curing. It should be borne in mind that only one percentage of calcium chloride and one brand of Portland cement were used. Different cements respond in different degree to calcium chloride as an admixture; furthermore, the high temperatures which prevailed had a favorable influence on early strength and may have minimized the effect of the calcium chloride.

(8) Indentation loads used in measuring surface hardness averaged 21 times the modulus of rupture; the greatest surface hardness was found for concrete of highest flexural strength. This method of test showed that calcium chloride, sodium silicate and air curing produced a more friable surface than wet-earth or paper curing.

Good Concrete at 23 Below!

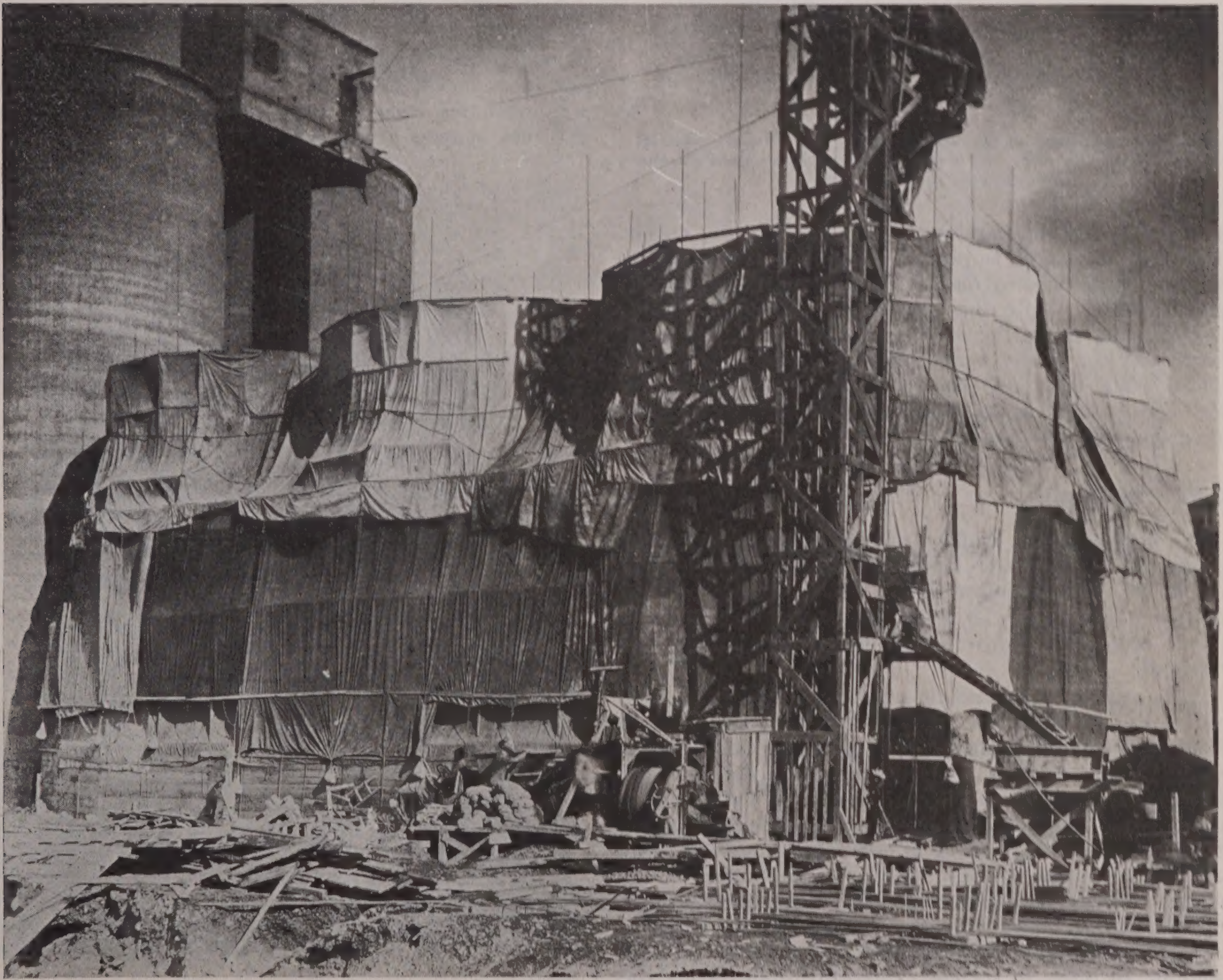
How Turner Construction Company Erected Cement Storage Silos in Extreme Weather Economically and Effectively—A Convenient Tarpaulin—General Pointers on Winter Work—A Word of Caution for Every Builder

When the thermometer falls to more than twenty degrees below zero and shows signs of staying there for the rest of the winter it is high time for the contractor to use special care in pursuing his concrete work. Some contractors have never even tried to concrete in this kind of weather, others have tried it and failed, and many others are doing it all the time, greatly to their profit.

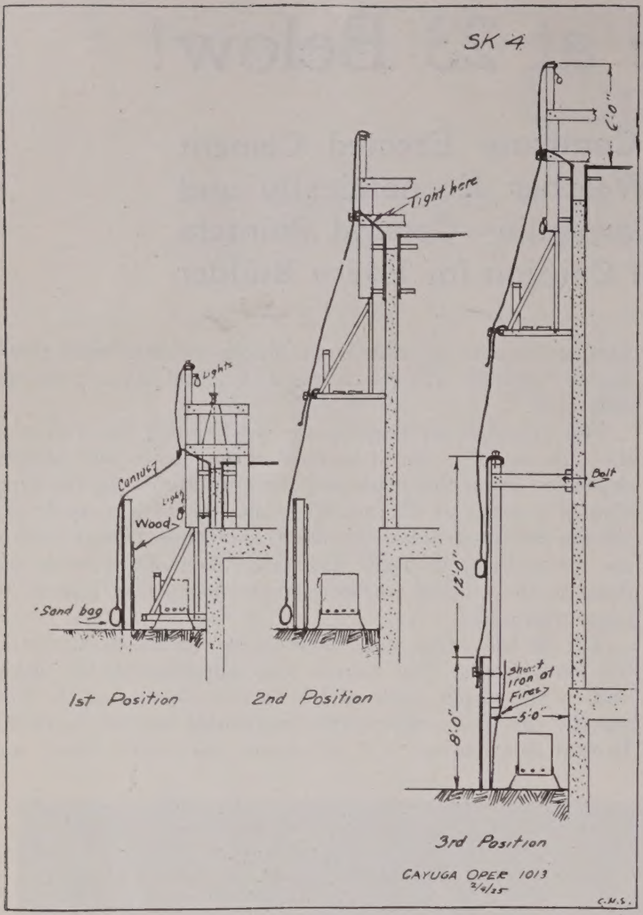
A very unusual example of concrete work under extreme weather conditions was to be observed last winter at Portland Point, New York, where the Turner Construction Company was called upon to erect a set of reinforced concrete silos for the storage of cement, using the sliding form method. Here, in spite of the fact that a great part of the work was done during January and February, during which time the temperature reached as low as 23 below zero, a carefully worked out system of protection against the cold permitted continuous day-and-night pouring of concrete. The result was a very fine job at a reasonable cost.

The principle of keeping the work warm was followed throughout. The actual method of enclosure and heating depended upon the work and the conditions. In the erection of a series of 80 foot silos one system was used, and during the construction of the 40 foot silos a more elaborate method was devised. The latter part of the work was done in the coldest weather, so the protection had to be more thorough.

The 80 foot silos were covered by canvas, as shown in the photograph. This canvas was supported on the upper end by the upper parts of the formwork, and at the bottom by the inner edge of the suspended mason's scaffold. Behind this canvas, a 2 in. steam line, with traps, was



The 40 foot bins were erected in sub-zero weather by means of this unusual system of tarpaulin protection, behind which plenty of salamanders were kept going night and day



The three positions of the enclosure for the 40 foot bins, as described in the story. A similar idea might be used on any structure of moderate height

laid on the scaffold, and was made to follow the outside of the bins, as nearly as possible, by the use of 45 degree elbows. Steam was furnished by the powerhouse of the cement plant. While this system of protection worked satisfactorily during the mild weather it was found to be insufficient for really cold weather. Salamanders were placed inside the bins. The steam line furnished protection against light frosts, and evidently assisted in hardening the concrete as it left the forms.

A Real Enclosure

The 40 foot silos, which were constructed during the months of January and February, when temperature as low as 23 degrees below zero were encountered, called for special attention. To protect the work an expansible canvas enclosure, shown in the sketch and photograph, was used.

This enclosure consisted of a wooden fence 7 feet high built entirely around the bins, and far enough away to allow the firing of salamanders between the bins and the fence. During the first stage of the operation a length of canvas was stretched as shown, fastened to the forms and weighted down on the outside of the fence by means of sandbags. As the height of the bins progressed, this first length of canvas was made fast to the bottom of the mason's scaffold, and another length fastened to that point and allowed to hang over the wooden fence, weighted with sandbags. This is illustrated in the sketch as 2nd position. In order to keep the enclosure tight during the final stages of the operation it was necessary to extend the fence vertically by adding another 14 ft. consisting of a wooden frame covered with canvas. This latter stage of the work is illustrated as 3rd position.

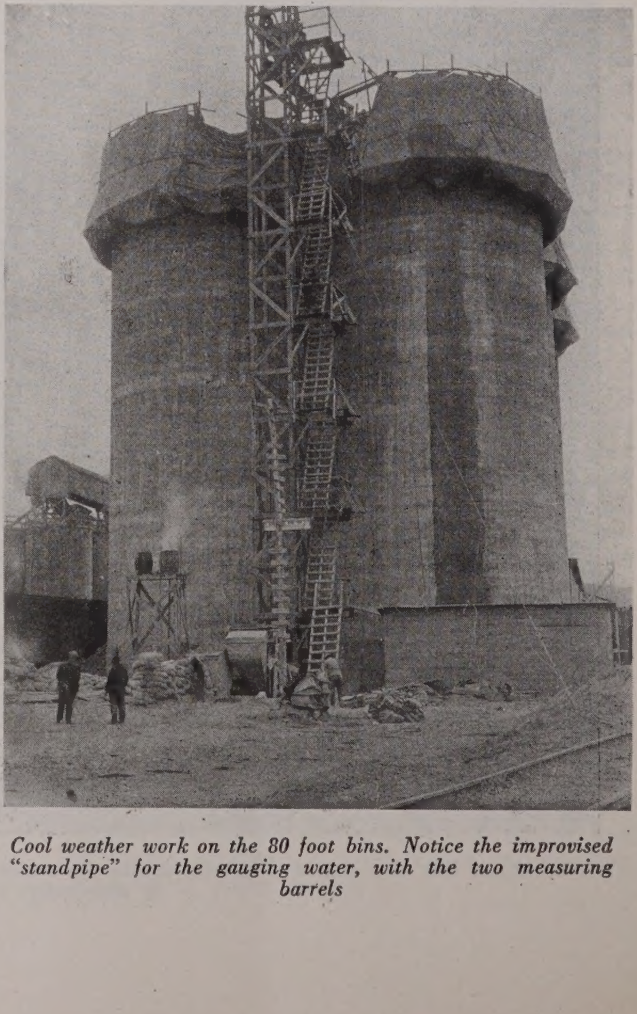
Three salamanders were used inside of each large bin, one in each star bin, and 35 distributed around the outside. No difficulty was experienced in maintaining a temperature above 65 degrees at all times, although it was frequently necessary to change the position of the outside salamanders to suit changes of the wind.

Scientific Methods

The mixing of the concrete was done out in the open, but constant delivery of thawed aggregates was made to the mixer by means of Ford trucks with small dump bodies. These dumped the sand and stone directly into the charging skip of the mixer. The cement was fed into the mixer by hand. Heated water, carefully measured, was used.

On this work, as on all other jobs erected by that concern, the aggregates, cement and water were proportioned by scientific methods, and due corrections were made from determinations of the water content of the aggregates. A scientifically designed mix, corrected for ordinary variables, was used. The mixes were designed on the basis of sieve analyses of aggregates, and the desired relationship between cement and water.

An odd feature of this job was that the usual temporary wooden trussess used in supporting the working floor were done away with, and in their place the permanent steel roof trusses were utilized. This was made possible by ordering these trusses with removable ends. When the top of the bin would be reached, the trusses were then extended, seated in chases that had been formed for them, and then concreted into place. Otherwise the form system was much the same as used on any of the sliding form and jack systems of erecting such structures.



Cool weather work on the 80 foot bins. Notice the improvised "standpipe" for the gauging water, with the two measuring barrels

Economical Tarpaulins

The tarpaulins ordinarily used by the Turner Construction Company are made of 12 oz., U. S. Standard Army Duck, 28½ in. wide. They come in two standard dimensions, 18 ft. by 60 ft., and 18 ft. by 20 ft. The longer tarps are intended for sidewall covering, while the smaller size is intended for top or roof covering, or on sidewalls when necessary. These are designed for good lapping, and are well provided with ropes and rings for splicing together and making them fast.

C. H. Schwertner, superintendent on the job herein described, stated that he is confident in his ability to produce the finest sort of concrete under any degree of cold weather to be encountered in this country, simply by means of the methods that he already is using on his winter work, and as part of the approved methods in use on all work under contract by the Turner Construction Company.

Why Heat Is Necessary

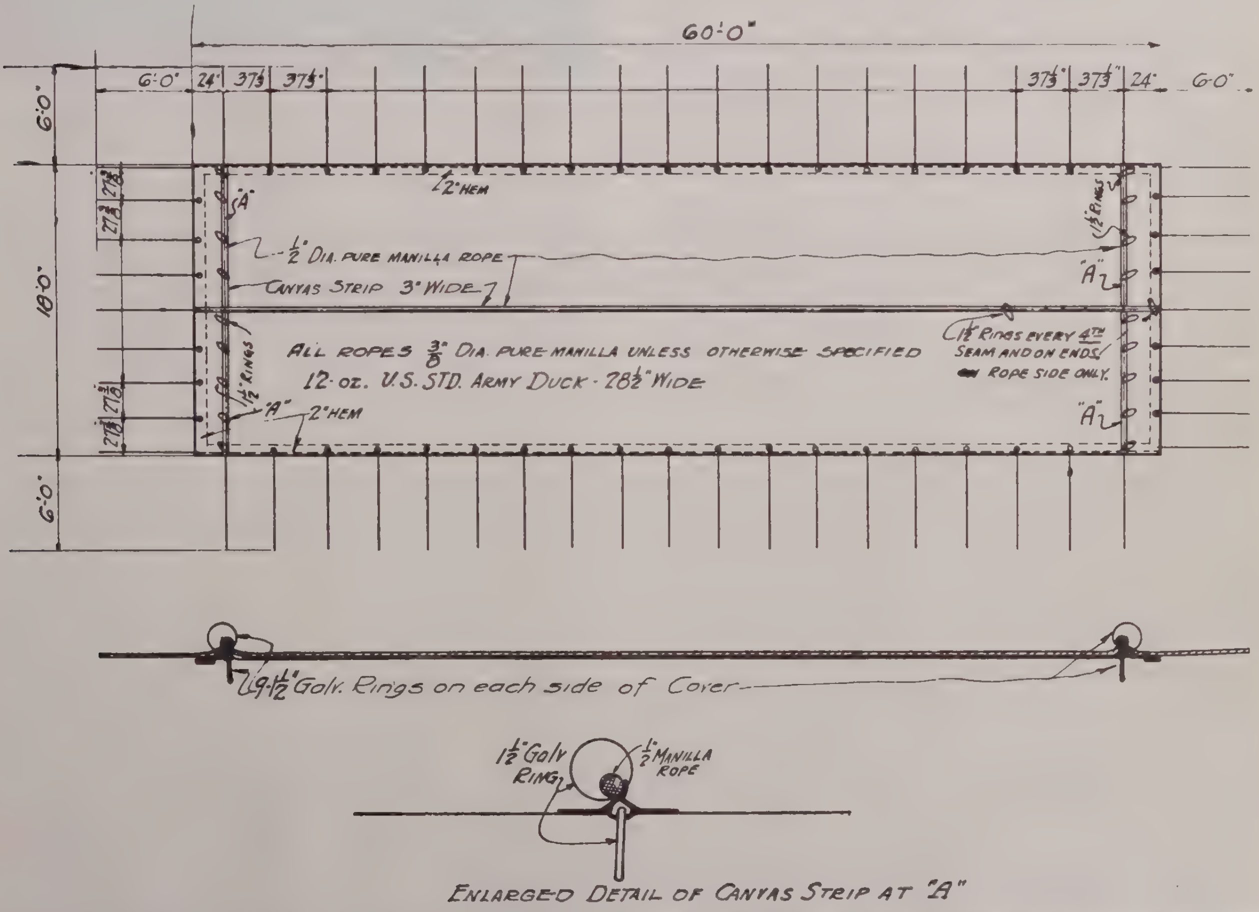
The success of the preceding work suggests to our mind the essential facts that must be considered by anyone undertaking winter concrete work. Perhaps it would not be amiss to pass along these reminders at the present time.

The setting of the concrete, we must remember, depends upon the setting of the cement. The setting of cement is a chemical reaction that is caused by the addition of a certain amount of water to the mass. The aggregates are simply inert materials that are to be bonded by the cement, thus forming a mass that we call concrete.

This action, being a chemical reaction, is governed by rules of chemistry, and by the limitations of the material.

The job completed, illustrating the class of work that was done under real winter conditions

Besides the factor of proportioning, the factors that influence the setting of concrete, and the strength of the material, are water, time, and temperature. Too much water will "drown" the reaction and therefore the concrete. The result is a lowering of strength as we all should know. Too little water reduces workability and retards hydration as well. The effect of temperature on the setting of concrete is one that is little understood by the average builder. Engineers will tell us, and they are right, that cold concrete will set up much slower than warm concrete. Most any chemical reaction can be easily speeded up by heating, or retarded by chilling. Cold concrete will not have the strength of warm concrete. These retarding factors bring time into consideration, because they


60'-0"
6'-0"
24"
37⅓"
37⅓"
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27⅜
27⅜
27⅜
27⅜
27⅜
27⅜
2" HEM
"A"
½" DIA. PURE MANILLA ROPE
CANVAS STRIP 3" WIDE
1½" RINGS
"A"
ALL ROPES ⅜" DIA. PURE MANILLA UNLESS OTHERWISE SPECIFIED
12 oz. U.S. STD. ARMY DUCK - 28½" WIDE
1½" RINGS
"A"
2" HEM
1½" RINGS EVERY 4TH SEAM AND ON ENDS ROPE SIDE ONLY.
"A"
9-1½" Galv. Rings on each side of Cover
1½" Galv RING
½" MANILLA ROPE
ENLARGED DETAIL OF CANVAS STRIP AT "A"

One of the tarpaulins now used as standard by the Turner Construction Company, after years of experience with all types of canvas determine for us the earliest time at which forms and centering may be safely removed. Give your work time to set, and give it more time in cold weather than in summer.

Turn Winter Into Summer

To make winter concrete work possible and practicable it is necessary to create artificial summer on the job, as nearly as may be possible. This means that materials and water must be heated, the job must be housed in, and some sort of heating arrangements must be provided.

The job may be economically enclosed with canvas, or it may be even more completely housed in by surrounding it with a temporary frame structure. There are various stunts for use on all kinds of work, many of which have been described from time to time in our pages. Heating may be accomplished by means of salamanders, warm air heaters, steam lines, or steam radiation. All have been used with success, but the more expensive systems are more adaptable to use on the larger jobs. Such protection should be kept in use until the structure has been declared safe.

No frozen materials should be allowed. Sand and stone are easily thawed out and heated by means of steam jets. This is the most widely utilized method on work where steam is available. On smaller work the thawing can be accomplished by piling the material over a section of culvert pipe or other tube, in which a fire is kept going. The water is heated in a boiler, by steam jets, or by special water heaters. Combination water heaters and salamanders are in wide use.

The concrete operations must be so enclosed that the batch should not have a chance to cool before it gets to the forms. The concrete should be kept heated at least until forms can be safely removed. Thermometer readings, and test cylinders should be made to govern the job. Never wreck forms until the check test cylinder representing that portion of the structure, and cured under identical conditions, has been broken and found to indicate sufficient strength.

A Word of Caution

A final word to builders—Don't think that concrete has not been hurt unless it is actually frozen. Read of what happened to another man, as told in this issue, and then realize that the temperature need only be 40 degrees to have your concrete reduced in strength a good 30 per cent. The danger line is really about at 55 degrees, and not at 32. Such temperature should necessitate an immediate use of winter methods, modified to suit the weather conditions.

Old Castle to Be Saved by Concrete

Durham Castle, one of the historic structures of England, and now a part of Durham University, is to be made secure for the benefit of future generations if the estimated cost of $150,000 can be raised by popular subscription or otherwise. The structure, built in 1160 A. D., surmounts a bluff that rises about 150 feet above the River Weir at a bend in the river. The growing instability of the famous structure recently caused an investigation. The test borings made by the engineers revealed that the castle stood on a very insecure foundation. For a distance of 25 ft. below the curtain wall (retaining wall) and of the Great Hall—now used as the University Refectory—there was nothing but freestone overlying a bed of soft shale with layers of unformed coal seams. Below this unstable material the borings revealed a bed of fairly hard rock.

Sir Francis Fox, who is taking charge of the project, has decided to use concrete in giving the building a more secure set of foundations. Reports state that the failing curtain wall, and other parts of the structure, will be grouted by means of compressed air, and that a new mass of concrete will be installed to carry the loads down to the bed rock. The new footing will be 25 ft. wide at its bearing, and tapering to a 10-ft. thickness where it joins the old wall. The loose material under the structure will be grouted to make it more secure.

New Storage Bin at York Plant

A conspicuous landmark on entering York, Pa., from the west by rail or by motor over the much-traveled Lincoln highway is the huge concrete silo recently erected and put to use for the storage of cement at the local plant of the Sandusky Portland Cement Co. The York plant is one of four operated by this company which manufactures a brand known as Medusa White in plain and waterproof grades. A shutdown of a plant of any sort in this, the third city of the industrial giant, Pennsylvania, as regards diversity of industries, is unusual. In this respect, however, the Sandusky plant holds an enviable record, for there has been no shutdown in more than seven years. This silo has a capacity of 70,000 barrels of cement with machinery for packing it into the containers as it is needed for shipment. The picture herewith gives a good idea of the size of the silo as it relates to the rest of the plant. Except for gypsum, all of the raw materials used in the manufacture of cement are obtained within a short distance of the plant. The Sandusky company, in addition to the York plant, operates mills at Sandusky and Toledo, Ohio, and Dixon, Illinois.

This is the new storage silo at the York plant of the Sandusky Portland Cement Co., designed to hold 70,000 barrels of cement

Change Likely in Road Policy

Congress probably will be requested by President Coolidge to make a change in the federal-aid road construction system. On the 50-50 basis the federal treasury suffers from the benefits derived by the states, in the President's opinion. It is understood that Mr. Coolidge believes that the federal-aid system should be continued, but that the law should be modified so as to restrict the demands of the states on the federal exchequer. The U. S. Treasury will pay out this year $170,000,000 on roads under the federal-aid system. This sum represents completion of existing contracts and also refunds to states which have paid the total cost of road improvements.

EDITORIALS

The New Stucco

Elsewhere in this issue appears a description of the new Portland cement stucco practice, which at last appears to provide a permanent and more adaptable way to use this plastic medium on all types of construction. On concrete units, this stucco provides a wall covering that will be very economical,—a covering that will remain in place as long as the structure itself will stand. On frame construction it provides a reinforced concrete slab, crack-proof and weather-resistant, that will place the frame house on a new level of worth, without appreciably increasing the cost of the structure. It is a worthwhile step in advance, and may be the thing that will do much to discourage the jerry-builder, provided that it is backed up by a safeguard policy and prices are held within range of actual cost. At last we have hopes of a stucco that will prove permanent, if the claims of the developers are born out.

Salesmen Needed

What the concrete products industry needs is more and better salesmanship. The matter of manufacturing good products has been very well worked out, for the time being, and a great many plants are in operation. We still see, however, instances of plants getting ahead on production. This is not a healthy situation, and needs attention. There is still room for many new plants, and for plant expansion and betterment, but in some localities the merchandising of the products is not done sufficiently well so as to fully develop the potential market. On the other hand this problem has been solved well by a few.

These successful merchandisers will discuss their solutions for the problem at the coming meeting of the Concrete Products Association. It will be worth while for every manufacturer to make it a point to attend and obtain the benefit of the valuable experiences of these other men.

Let us not forget that a good salesman is worth having—but not in the plant.

A Worthwhile Activity

A subscriber in Santa Barbara, California, sent us the following unusual request, and opened up a line of thought that every construction man ought to consider. Here is what he wrote us:

> "Can you put me in touch with the (reserve officers') department in Washington, D. C., that has a concrete department?
>
> "This is what I want: To join the reserve officers as a concrete engineer. This will put me in personal contact with some of the biggest concrete men in the country. In time of war and in time of peace, as well, we fall far short of the concrete engineer, so why not put him on the list now? I would like to see every member of the American Concrete Institute such an officer, and spend a month of each year at military camps. I know there is a lot we could see in the way of concrete foundations, rifle pits, and other things. There is lots to give and lots to receive."

We have been able to place the writer in touch with the proper authorities and hope that he will be able to secure the coveted commission.

Other engineers, and construction men, should give this subject careful and serious thought. It is a professional activity that should not be disregarded, for it is an activity that must be carried on by the profession. It requires but little time at present, but prepares a man for real usefulness in case of emergency, and gives him a medium for discussion and work that in the past has resulted in things that have proven a benefit to the construction industry.

The man who is fortunate enough to be given the right to take part in this branch of engineering activity is better able to serve his profession, his community, his state, his nation—and himself.

Build It Right!

The recent failure, described in this issue, may have done a great harm to the construction of concrete buildings in that portion of the country. In spite of the fact that many successful buildings have been erected in the vicinity, and all over the country, this one mishap was widely commented upon by all those who saw the affair, or read about it in the public press, as proving that reinforced concrete was not a safe type of construction. Because this one builder did not know how to successfully pursue winter construction he has brought about some popular misconception of the worth of concrete. This was a greater harm than the financial loss that he himself incurred, and it is to be deplored.

The man who is intrusted with the erection of any structure, concrete included, should be fully aware of the hazards of the work, and should be fully able to pursue the work to a successful culmination. The public does not remember successes as well as it remembers failures. If we wish to further the use of concrete we must be governed accordingly. There is no excuse for failures of the type of this one. Our engineers have told us time and again that concrete sets slowly in cool weather, but once in a while we find a builder who will not believe us until he has tried it himself. It's an expensive way to teach this type of man his lesson, but it seems to be the only way to teach certain types of men.

Every builder of concrete owes it to himself and to the industry to constantly study his technical journals in order that he will better know how to do his work well, with economy.

Education will prevent further incidents of the type described. We have thus reported the event and its cause for the attention of our readers.

Concrete Poles Now Widely Utilized

Accepted by Many, Concrete Poles Extensively Replace Wood, After a Long Period of Experiment and Development — Early Developments and Investigations—The Growth of the Industry—Some Unusual Poles and How They Are Made

(Concluded from November)

From this time onward the progress became rapid. The preceding tests and trials had more or less established several different ideas in pole design, ideas that are being extensively used today. Concrete poles, including two 150 foot poles carrying lines across the old Welland Canal, that were built twenty years ago are still standing. Others failed to live up to expectations and were abandoned in favor of more correct designs. Two new ideas introduced during the first ten years of this century were the cast *in situ* poles of the American Concrete Pole Company, Richmond, Ind., and the hollow poles built by the Oklahoma Gas and Electric Company. The latter, hexagonal in section, were reinforced by twelve ¼-inch high carbon steel rods, with mechanical bond, spaced symmetrically about the center. Steel plates held the rods at each end, and initial tension was given at manufacture by means of a special process.

The forms in place for making the Rochester pole

The preceding experiments were not all that were carried on up to 1910, but are representative of the kind of work that was being done. The result was a number of types of poles for many uses, designs that worked well enough but which were in many cases found susceptible to improvement.

Committee Investigations

In 1913, and during the following few years, the Committee on Power Distribution of the American Electric Railway Engineering Association went into the question of the design of concrete trolley poles, and worked up a number of formulae for poles of different section. As a result of their investigation several points were brought out that have had a bearing on all work done from that time. The notable facts were as follows:

1. Failure of a pole is always due to stretching of the reinforcing rods on the tension side.
2. A failure is always preceded by the appearance of hairline cracks in the concrete on the tension side,

View in pole plant of Rochester Gas & Electric Co. This plant is under roof and operates all the year, making from eight to eleven poles a day, as well as ornamental street lighting standards

Part of the pole plant of New York State Railways, Rochester. Eight home-made steel forms are used, and after eight years of use they are still in perfect condition, after forming about 2500 poles. They are light and simple, and cost but little at rather frequent and regular intervals from the ground line up.

3. It is advantageous to use a high grade of reinforcing steel to secure the maximum tensile strength.
4. Plain round reinforcing rods are essentially as satisfactory as twisted or other rough rods, because, in general, the rods will elongate before they slip in the concrete.
5. A larger number of small rods is preferable to a smaller number of large rods, as a better distributed reinforcement may be secured for a given amount of steel, and a better bonding contact surface is presented to the concrete.
6. The reinforcement need not be uniform throughout the length of the pole, but may be stepped off as the top of the pole is approached.
7. A pole with uniform reinforcement will break at the ground line, while one with tapered reinforcement will break at some point above the ground, depending upon the taper of the reinforcement.
8. A concrete pole has an element of safety in it, as a failure of the pole will not, in general, allow it to fall to the ground. It is difficult at times to pull over a pole after failure, even though it is inclined at a large angle from the vertical.

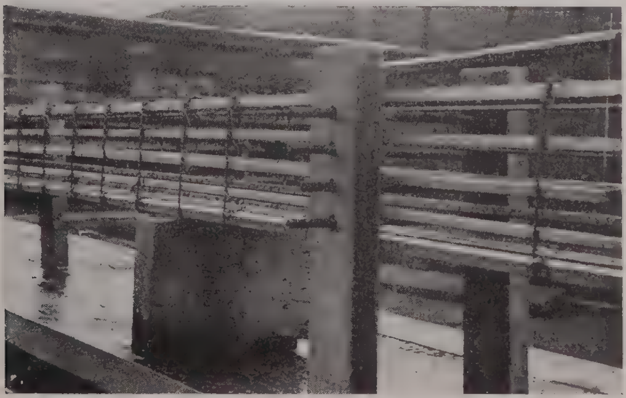
These ideas were the result, then, of the investigations undertaken up to 1915. These, plus some satisfactory designs, and some practical manufacturing methods, and the few approximate formulae that had recently been proposed, were the sum total of scientific knowledge of concrete poles up to that period.

Beam Theory Was Applied

By the following year, 1916, a great deal more thought and investigation had been given to the subject, so that the report of the committee in the convention of that year included a general theory of design based upon the assumption that a reinforced concrete pole was essentially a reinforced concrete beam and acted in the same manner. Special characteristics, however, made necessary the use of a new set of constants. It was admitted, as well, that there was some doubt as to whether the ordinary theory of flexure, with its two usual assumptions, could be made to apply. Results were sufficiently accurate, however, to permit the use of the established theory, except that stress-strain diagrams should be used where final accuracy might be desired, the committee reported. On this basis, corrected formulae were worked out and submitted for use.

Current Revision

The same committee of the American Electric Railway Engineering Association in 1924 finally worked out a



Here is the reinforcement used in the trolley pole made by the United Railways, of St. Louis. Five-eighths and half-inch bars are employed

Tests on concrete trolley poles at Kendallville, Ind., by the Indiana Service Corporation, of Fort Wayne. Deflection was measured from the string and the load read from the dynometer. Poles broke at loads around 1800 pounds

Note the heavy loading carried by these concrete poles used by the New York State Railways, at Rochester, N. Y. They are replacing wood poles individually as fast as the latter fail

Here is the storage yard and overhead crane for handling the poles at the plant of the Baltimore Ry. & Elect. Co.

standard set of specifications for reinforced concrete poles for electric line construction. These specifications are now being revised (1925) and are typical of reinforced concrete pole specifications of this time. The 1925 committee has also given attention to matters of theory and design, and has worked out a more modern set of formulae and specifications that should result in even more successful poles. The Association, which met in October, had the committee report on this work presented to it for consideration.

An Important Canadian User

Several companies have made extensive use of reinforced concrete poles during the past twenty years. One of these organizations, the Toronto Hydro Electric Commission, adopted them for their distribution system before 1909. Since that date over forty thousand poles have been cast. These poles, which have been of a very light design, have for the most part been only 24 feet long, of which 4 feet is below the ground level. Some have been made 30 feet high. They are 8 inches square at the bottom and 5 inches square at the top, with corners beveled ¾-inch on each side. They are reinforced with four ⅜-inch square twisted bars, one in each corner 1¾ inches from each face. The poles carry brackets for six wires, three pairs located 6 inches, 21 inches, and 36 inches respectively from the top of the pole. These poles also carry a street light about 12 feet above the ground.

Experience has proven this design too light, but a correct design would be little different from that hitherto used. Some of the poles have deteriorated somewhat by corrosion of reinforcing steel too close to the surface. All poles are still in service and most of them are good for many years' use.

An Eastern User's Experience

One of the largest users of concrete trolley poles is the New York State Railways, operating lines in Rochester, Syracuse, Oneida, Rome, Utica and Schenectady, as well as interurban lines throughout central New York. They started the use of concrete poles in Syracuse as early as 1910 or 1911, and in Rochester a year or two later.

The poles at Syracuse are square with beveled corners, while the ones used at Rochester and Schenectady are octagonal in shape. They were cast in lengths of 30 to 45 feet. The poles are manufactured in plants located at each city. Each plant is located at a gravel pit on the company's property and connected to the company's lines with switch tracks.

The Cleveland Railways Company has been using concrete poles for over ten years with excellent results. A summary of their investigations and experience can be found on pages 101 to 102 of CONCRETE for September, 1923. The initial cost of the new design ran slightly under $16 per pole.

The United Railways of St. Louis has been using a number of poles quite like the Cleveland ones. The United Railways and Electric Company of Baltimore has been using a square concrete pole for several years, and recently put into operation a complete plant for manufacturing all that they require. The Virginia Railway and Power Company have been using concrete trolley poles in Richmond, Norfolk and Petersburg.

Most Poles Made by User

While all the above companies have manufactured their own poles the Pittsburgh Railways Company have a number of poles in service that have been purchased from a products manufacturer. These are hollow circular poles made by the centrifugal process and seem to be giving excellent satisfaction. The Rochester (N. Y.) Gas and Electric Corp. are making light distribution poles. These poles are square and hollow. The central space is formed by a mandril that is withdrawn as soon as the concrete has taken its initial set.

The Pennsylvania Railroad has a number of installations of concrete poles that are in excellent condition after more than twelve years of service.

The "Hollowspun" Pole

Mention has been made of the round hollow pole made by the centrifugal process. By this process, known in this country as the "Hollowspun," poles are now being manufactured by the Westinghouse Electric and Manufacturing Company. Trolley poles, transmission poles, and lighting standards are commonly made in this way. The "Hollowspun" centrifugal process makes it possible to produce a slender concrete pole without sacrifice of strength or durability, it is said. The process was described in CONCRETE for October.

A Light Weight Pole

Another odd type of pole is that invented by J. G. Jackson, manager of the Chatham Hydro Electric System, Chatham, Ontario. This pole, originally described in the technical press about 1914, is a truss design of minimum weight. Each member of the truss-like pole is designed

The pole plant of the Baltimore Ry. & Electric Co., is under cover, and is well equipped with cranes for handling forms and finished poles. Steel frame of building and carrier for poles made of old girder rails. Forms are quite heavy, being made of channels with wood strips to form bevels on corners to withstand individually the several components of the applied stresses, with the result that the strength of the pole is almost directly proportional to the spacing of the members.

The design is based upon a skeleton steel framework with allowance for tensile and shearing stresses only, and a sufficient area of cement or concrete is then added to the cross section to bring the compressive strength and resistance to distortion, up to the full tensile strength which the opposing member will develop. Inasmuch as an ordinary steel truss will fail at a much lower unit stress in the member in compression than could be developed in tension, it is possible to produce the desired strength with a less cross section of steel in the longitudinal members and, owing to the stiffness of these members, to dispense with the greater part of the latticing ordinarily required in steel truss construction. The cement is armored and retained by means of a steel mesh imbedded just under the surface over the entire area of the structure. This steel mesh also acts as a web to retain the steel in its proper location and to assist in distributing the stresses. Poles made in accordance with this design are principally in a flexible type of Z shape adapted to take strains normal to the line, or in a V shape arranged for symmetrical or unsymmetrical loading as required. Weights of poles for the ordinary purposes of electrical distribution would run approximately 10 lbs. per lineal foot.

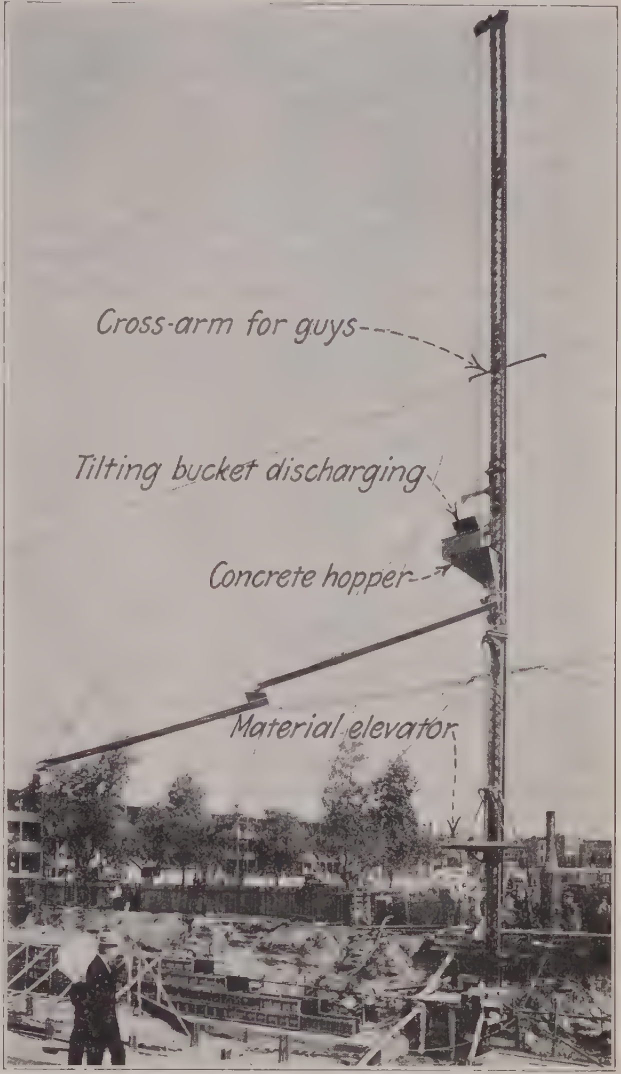
Conclusion

The preceding notes, while fragmentary in character, indicate the great advance that has taken place in concrete pole design since the first monoliths were erected in Panama prior to our Civil War. At this time light-weight, strong, and durable poles or lighting standards can be manufactured at a cost that will enable them to compete favorably with poles of wood, iron, or steel. In many cases, while the first cost may be a trifle higher, the unusual life and freedom from maintenance will more than make up for the difference in original cost. The pole business is a good one for the would-be manufacturer who will turn out a quality product.

New Tower Hoists Used on Important Work

A tower hoist and spouting system that has several meritorious features, recently developed by the Archer Iron Works, Western Avenue and 34th Place, Chicago, Illinois, is now being used with apparent success on the construction of the new medical buildings at the University of Chicago. The William Adams Company, general contractors, are chuting about 25,000 cubic yards of concrete with the aid of three of these plants, and report that they are quite practical in operation. Two of these towers are 160 feet high, while the third is 120 feet high. Without using high lines or counterweights the concrete is being delivered, it is said, to the forms from 150 to 300 feet away from each mast. With a hoist bucket capacity of 18.6 cubic feet, a tower hopper capacity of 1 cubic yard, and a hoisting speed of 180 feet per minute, the concrete is delivered in such a volume as to keep the job moving all the time.

The new Archer system, which is built in two sizes, consists of one bottom section of steel tower 20 feet high, and as many additional 20-foot sections as may be required. A maximum height of 140 feet may be used when guy supported, while any desired height may be used when the tower can be rigidly fastened to a building. With each tower the manufacturers furnish a patented hoist bucket, which dumps into a receiving hopper fastened to a sliding frame, which moves up and down one face of the tower to any height required by the work. This hopper is provided with a gate to regulate the flow of the concrete to the chute or to the buggies. Two top sheaves, 14 inches in diameter with boxes, are furnished, as is one bottom 14-inch swivel sheave. A 30-foot steel gin pole is provided for erection purposes. This gin pole is fastened to a steel sliding frame, and is made to slide up the face of the tower, so that additional tower sections may be raised into place.



One of the new Archer tower hoists and chuting systems that are helping construct the two new medical buildings at the University of Chicago

Concrete can be discharged directly into buggies, may be spouted to a central hopper that discharges into buggies, or the concrete may be spouted to the forms, by means of this tower and the required boom spouts.

These towers have been used recently on quite a few Chicago jobs, and are said to have proven successful, economical and efficient.

Modern Highways Call for This Kind of Cement

By A. T. GOLDBECK
Formerly Chief, Division of Tests, U. S. Bureau of Public Roads

This paper discusses the service requirements of concrete in concrete pavements giving the most destructive influences as those which produce tensile stresses in the pavement.

The conclusion is drawn that concrete for highway construction would be even more suitable from a technical standpoint than it is at present:

1. If it developed high tensile strength within a very few days.
2. If it had a very low shrinkage factor under the action of moisture and temperature.
3. If it were even more durable in its long-time resistance to alternations of freezing and thawing, wetting and drying, changes in temperature and repeated loads.

The paper discusses further the various properties of cement that might be given further consideration and the attitude of various state highway testing engineers on the necessity of changes in the current specifications.

The use of portland cement for pavement construction has developed with great rapidity in the last fifteen years. Thus, we are told, "In the five-year period, 1909 to 1913, which comprises the early days of concrete roads, less than 1.5 per cent of the cement produced in the United States was used for pavements. In the five-year period, 1920 to 1924, this was increased to nearly 20 per cent. At the present time, 25 per cent of the cement made is being used in pavements of various classes."[1]

As an example of the large mileage of concrete pavements constructed in this country it might be stated that the Federal government has co-operated with the various state highway departments in the construction of over 10,000 miles of concrete pavements, and it is estimated that 34,000 miles of concrete pavements have been built in the United States by the various municipalities, county, state, Federal government and other highway constructing agencies. Many miles of pavement surfaces remain to be constructed, of which a high percentage will undoubtedly be built of portland-cement concrete. Such construction involves the expenditure of hundreds of millions of dollars for materials alone, and a considerable portion of these funds will be used for the purchase of portland cement.

In the light of these figures it is important that we know whether or not the present standard specifications for portland cement are written in a manner such that the most economical and, in general, the most satisfactory concrete pavements will be built. Is it possible that the standard requirements for portland cement should be altered in some respects to produce a cement more suitable for pavement construction than the portland cement now available under our present specifications? Is it possible that the particular demands made on concrete pavements render it advisable to use a particular quality of cement having properties not possessed by our present portland cement and, if so, is it likely that economy will result from the use of this special cement? These are questions which many highway engineers have been asking themselves because of their responsibility as public servants of obtaining the most economical highway service for the huge sums which they are expending.

Service Requirements

That we might have a better understanding of the qualifications of portland cement for pavement construction it will be well to review very briefly the various influences to which concrete pavements are subjected, tending toward their gradual deterioration, for too frequently the fact has been overlooked that concrete highways are subjected to many forces other than traffic loads.

If the history of the concrete in a pavement be followed through from the very beginning, some understanding will be had of the properties which road concrete should possess. When the wet concrete is placed on the subgrade, unless the proper precautions have been taken to insure against rapid absorption of water by the subgrade or against rapid evaporation of moisture from the surface of the concrete shrinkage begins and cracking or crazing might result immediately. The unequal swelling of the subgrade might produce local bending of the setting concrete with the production of high tensile stresses at a time when the concrete has practically no resistance to tension. If the concrete is kept moist during its initial curing period its slight expansion due to moisture will result in a small and harmless compressive stress, although all too frequently contraction begins even in this initial stage due to insufficient moisture. During the curing period there will be daily fluctuations in temperatures resulting in expansion during the day with the production of compressive stress and in shrinkage at night with the production of direct longitudinal tension. At the end of ten or fifteen days when the usual curing period has ended, the concrete is allowed to dry and it shrinks with the production of tensile stress due to the frictional resistance of the subgrade. Sufficient longitudinal tension might be produced to form transverse cracks at frequent intervals. Such transverse cracks are inevitable unless they are built into the pavement through frequently spaced expansion or construction joints. In the meantime, during the day,

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A paper presented at the 28th annual meeting of the American Society for Testing Materials, at Atlantic City, N. J., June, 1925.

[1] The "Contribution of Scientific Research to the Development of the Portland Cement Industry in the United States," by D. A. Abrams, Professor in Charge of Laboratory, Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill.

the sun heats the top surface of the concrete, thereby expanding it, while the bottom surface remains at a more uniform temperature. The effect necessarily is to warp the pavement slab, cause it to bear on the subgrade at the corners and edges and to rise somewhat along the center. At night the reverse is true, the top surface contracts and the bottom surface remains more stationary. The corners and edges now rise and in many cases actually leave the subgrade. High bending stresses are thus again produced and every day the pavement goes through this cycle of bending. During long-continued periods of wet weather the concrete takes up moisture and expands, and when this expansion is combined with the expansion due to high temperature, the concrete is subjected to high compressive stress longitudinally, so-called "blow-ups," sometimes take place and the pavement heaves in spots away from the subgrade. This phenomenon is especially prevalent in the spring of the year, for this time is favorable to the combined expanding effect of high moisture content and high temperature. The action of freezing on concrete pavements should not be overlooked. Such action is especially noticeable where improper materials or construction methods have been used and it results in the scaling of the surface. The influence of the quality of the cement in the production of such scaling is in need of investigation.

Bending Stresses

Under traffic the pavement is subjected to very severe bending stresses and tension occurs both at the top and at the bottom of the slab, depending upon the position of the load. Concrete is not particularly strong in tension, its value being only from one-eighth to one-twelfth of its compressive resistance. Bending stresses are to be feared because of this inherent quality of concrete to be weak in tension. It is the practice in most localities to permit traffic on concrete pavements in the very early stages of their hardening. For instance, in some states heavy trucks hauling construction materials are permitted even at the end of 15 days when the concrete has gained little strength in tension, and invariably traffic is allowed on the pavement at the end of 21 days, when the bending resistance of the concrete is still small.

It is thus seen that concrete pavements are subjected to a variety of influences which tend to harm them and these influences must be combated by the use of proper materials, proper design and construction methods. In general, the most destructive of these influences are those which produce tensile stresses in the pavement and may be tabulated as follows:

1. Shrinkage of concrete due to drying of moisture.
2. Contraction of concrete due to decrease of temperature.
3. Warping of the slab due to variations in temperature and moisture.
4. Bending due to heavy wheel loads applied frequently.
5. Bending due to non-uniform subgrade support.
6. Excessive compressive stress due to rise in temperature or increase in moisture content or a combination of both.
7. Frost action.

An analysis of the above influences leads us to the conclusion that concrete for highway construction would be even more suitable from a technical standpoint than it is at present:

1. If it developed high tensile strength within a very few days.
2. If it had a very low shrinkage factor under the action of moisture and temperature.
3. If it were even more durable in its long-time resistance to alternations of freezing and thawing, wetting and drying, changes in temperature and repeated loads.

Technically then, concrete having high early tensile strength which would be maintained over a long period of years would be very desirable for concrete pavement construction. Investigations of concrete have shown that strength is very largely dependent on the ratio of volume of water to cement used in the mix and that the so-called "water-cement ratio," assuming a given kind of cement, is the most important factor governing the strength of the concrete. It is logical to infer that the use of a higher strength cement or the use of more cement must likewise lead to higher strength concrete. Several ways are thus open to the engineers who are seeking concrete of higher strength, such as drier consistency, more cement, better aggregates both in quality and gradation and finally higher-strength cement.

In the light of the previously discussed desirable properties for highway concrete let us inquire into our present standard test requirements for portland cement, so far as that seems possible, to see to what extent they insure the production of cement which will make satisfactory and economical highways.

Fineness

The specifications require that not more than 22 per cent residue shall be retained on a standard No. 22 sieve. The question arises whether or not it would be desirable to require the use of a finer cement. It has been shown in connection with the work of the Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement, in a report published by Committee C-1 of the American Society for Testing Materials dated July, 1919, that there is only a slight increase in the strength of portland cement with increased fineness, and also a slight increase in the crushing strength of concrete. Thus, 1 per cent reduction in the residue on the No. 200 sieve resulted in about 1.3 per cent increase in the crushing strength of 1:2:4 concrete at 28 days. No figures seem to be available on the effect on the tensile strength or resistance to bending.

Whether the extra cost of finer grinding is justified by the slightly higher strength obtained in the concrete does not seem to be established. Information is needed on this point. Information is also needed on the effect of fine grinding on the durability of the concrete. The effect of fineness on deterioration in storage is also to be considered.

Soundness Test

It is a question whether the soundness test as now made is really suitable for bringing to light the qualities undesirable in cement from the standpoint of highway construction. A quantitative test for soundness of cement should be investigated to indicate degrees of unsoundness.

High shrinkage of concrete is undoubtedly due largely to the shrinkage of the cement and it is recognized that different cements shrink and expand differently with moisture changes. Some quantitative test of the volume change of cement might be desirable for judging of its value for concrete road construction.

Tensile Strength

It would seem that unquestionably the tensile strength of cement must influence the strength of the concrete in tension and cross-bending, and it would seem also that cements having the highest tensile strength should be more suitable for highway concrete than those of low strength. Technically, high early tensile strength is to be desired, provided the strength will not decrease with age.

It is recognized of course that other factors influence the concrete strength even more than the variation in the strength of the cement. While the available test results are not entirely concordant in showing increased concrete strength with increased strength in portland cement as now tested in the form of 1:3 mortar briquettes, the trend is certainly in that direction and this trend is well illustrated by tests with high-alumina and other special cements. In certain localities it would be quite practicable to raise the test limits for tensile strength without inflicting any hardship on the manufacturers and without causing them to change their methods of manufacture or the characteristics of their output. In a very few instances, on the other hand, an increase in the tensile strength requirements would be difficult to meet and, in fact, would bar the production of certain mills. Here again, the technical features of the specifications must be considered in conjunction with the economics of the resulting concrete in the highway.

Highway engineers would welcome cement of higher tensile strength, especially in the early period of hardening, provided durability and economy are not sacrificed. Highway engineers would also welcome a strength test that could be made after a few days instead of seven days and they would like a refinement in the tensile test which will eliminate the wide variations in test results which are now possible. A reversion to the neat test has been suggested. Let it be remembered that we are concerned with the mortar and concrete-making properties of cement and that fineness of grinding has a different effect on the neat and mortar strengths.

The setting time of portland cement under certain conditions might well be regulated so that the concrete would set up faster than at present. At times it is difficult to maintain a smooth finish on a concrete road owing to the slumping of the concrete down grade after it has been finished. A quicker setting cement for this purpose would be desirable and, of course, a quick setting cement would be desirable for cold-weather conditions. Cement complying with the low limits of the specifications; however, should be satisfactory for the above conditions, but otherwise the present test limits for time of set are suitable for concrete road construction. Instances are recorded of cements passing the Gillmore test and failing in the Vicat test. We should not be satisfied with our present methods of testing for time of setting. They need more careful control.

It is not felt that any of the other tests for portland cement need discussion so far as concrete pavements are concerned.

Opinions of State Engineers

In order to gain the ideas of the materials engineers in the state highway departments on the necessity of any changes in the cement specifications, a letter was addressed to them and also to the district engineers of the U. S. Bureau of Public Roads in which the following questions were asked:

1. Specifically, have you information showing whether or not cement which just passes the specifications will or will not make good concrete?
2. Have you any test results co-ordinating the tests on cement with the strength of concrete made from various brands of cement having various physical properties?
3. Have you any definite ideas as to whether or not the requirements for portland cement should be made more severe?

In brief, the answers to the first two questions revealed very little information. There are some test results showing higher-strength concrete with higher-strength cement, but there seems to be no definite information on the value of concrete made with cement just passing the present standard requirements. Of the thirty engineers replying to the third question, ten were in favor of making the tensile strength limits more severe because they thought that a better quality of concrete would result, while the remaining twenty did not advocate changing the present standard specification. Several of the state engineers were dissatisfied with the reliability of the soundness test, others believed finer grinding desirable. The advisability of a strength test which could be made in a few days was also stressed.

Early Strength Needed

The situation with regard to the portland cement specifications as they apply to concrete road construction might be summed up by the following general statement:

As a whole, very satisfactory concrete roads have been built with cement passing our present standard requirements. As a rule, however, most brands of cement fall well within our minimum test limits and some doubt has been expressed whether low testing cement is really satisfactory for concrete pavements because of the high early stresses to which pavements are subjected. It would seem that technically high early testing cement should lead to still better construction. Economically this has yet to be demonstrated. If high early strength can be attained with no decided increase in cost and no danger of disintegration, surely it is justified and desirable and is something which cement manufacturers should look forward to. It is felt that in many cases where cement is testing low, the mill practice is at fault and much better results would be possible if such mills would exercise more meticulous control over their product. There is no question in my mind that the general standard of quality of portland cement can be raised merely through careful manufacture on the part of all of the mills instead of in some of them.

Highway engineers are anxious to secure concrete of high early strength and great durability. In general, they recognize that several ways lead to this end, one of which is the use of cement even more suitable than at present available. Perhaps their goal may be reached by the use of higher quality cements. That is well worth investigating, but the making of concrete highways is costing vast sums and technical questions are not alone involved. Caution is necessary that too hasty action be not taken before the full facts have been demonstrated. Several organizations and committees are at work in an effort to improve the quality of cement, the methods of testing cement and the specifications for its control. These committees are not unmindful of the qualities of cement so much to be desired, but they likewise are fully impressed with the difficulties with which they are confronted. They, however, are earnestly trying to ascertain the facts and to use them for improvement of cement and cement specifications.

So to manufacturers I would say there is a growing feeling that a higher quality of cement is desired and that some manufacturers at least can and should improve their product for highway construction.

To highway engineers my message would be that they are justified in their attempt to obtain concrete of higher tensile or cross-bending strength, but the means adopted, whether better cement, more cement or better concrete control, should be based on established facts and it should be remembered that economic as well as technical questions are involved.

A Unit Wall That Is Reinforced

This New System of Pre-Cast Unit Construction Permits Adequate Reinforcing. It Provides Double Wall Without Connecting Webs—Adaptable to Almost Any Structure —Erection Cost Very Low

We were visited the other day by a man who has another way to erect concrete houses. This builder, H. E. Clouser, hailed from that state that is noted for its bathing beauties, its oranges, and its new developments in concrete houses—California. He had a story to tell, a story that we are passing on to you for what it may be worth.

It seems that years ago, while engaged in his trade of carpenter, and in his business of builder, that he, like many others, began to wonder why it would not be possible to erect homes of enduring concrete with as great economy as he was used to building homes of wood. Then, after a lot of investigating and a lot of thinking, the idea came to him. The result is his Thermotite Construction, the thing that he had come in to tell us about.

He informed us, and showed us by pictures and other data, that this system had been in use for the past six years, and that during the first three years about 400 of these buildings were erected. After extensive changes and improvements the patents were secured and the thing made an established fact. So greatly has the idea grown in his own section that his firm, he claimed, had erected over 600 buildings during the past eighteen months, and were now going in for some very large construction—stuff that is usually given over entirely to reinforced concrete, to brick, and to steel. For a brand new "concrete products" idea that in itself is worthy of note, it seemed to us.

Thermotite Construction, our visitor told us, consists of nothing more nor less than a double wall of solid concrete units, grouted together with locked joints, and tied together scientifically with reinforcing steel around the wall, and horizontally and diagonally through the wall. It is something that has been declared, he said, to be perfectly sound, dry, stable, permanent, fireproof, and earthquake proof by a very prominent structural engineer who resides on the west coast. Here is the way he explained it to your editors, as we sharpened our pencils over the drawings and examined the many photographs that he brought in to us:

Pre-Cast Units Used

The Thermotite structure is based upon the use of solid units of concrete, produced in a tamping machine and special molds. These units, of a 1:5 mix, are giving average compressive strengths of 2,000 pounds per square inch on the 28 day basis. They are manufactured in a rather plastic condition, being given about enough water to produce a mix with a slump of about four inches. The moulds are of bronze, and are of such a nature that accurate and speedy production is possible. There are five ordinary units: the Standard, the Corner unit, the Lock unit, the Column unit and the Paving unit. The Standard units are made in thicknesses of 2½ in., 3 in., and 4 in., in heights of 4 in., 6 in., and 8 in., and lengths of 2, 4, 6, 8, 10, 12, 14, and 16 in. The other units for various structural purposes are made in suitable dimensions to correspond to the size of standard unit to be used. With this assortment of sizes available the builder can figure his work to reduce cutting of units to almost nothing, if not eliminate cutting altogether.

Tongue and Groove

On the Standard unit a tongue extends around one side

The Paul Flanders residence at Carmel, Calif. Built of double 3-in. Thermotite walls. H. H. Gutterson, San Francisco, architect

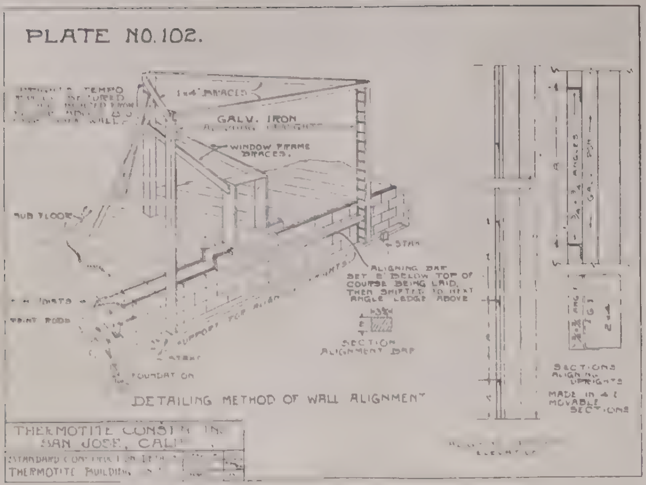


PLATE NO. 102.
1×4" BRACES
GALV. IRON
WINDOW FRAME BRACES.
SUB FLOOR
JOISTS
STAK
ALIGNING BAR SET 2" BELOW TOP OF COURSE BEING LAID, THEN SHIFTED TO NEXT ANGLE LEDGE ABOVE
SECTION ALIGNMENT BAR
SUPPORT FOR ALIGN
STAKE
FOUNDATION
DETAILING METHOD OF WALL ALIGNMENT
SECTIONS ALIGNING UPRIGHTS
MADE IN 4 & MOVABLE SECTIONS
ELEVATION
THERMOTITE CONST'N INC.
SAN JOSE, CALIF.
STANDARD CONSTRUCTION DETAILS
THERMOTITE BUILDING UNITS

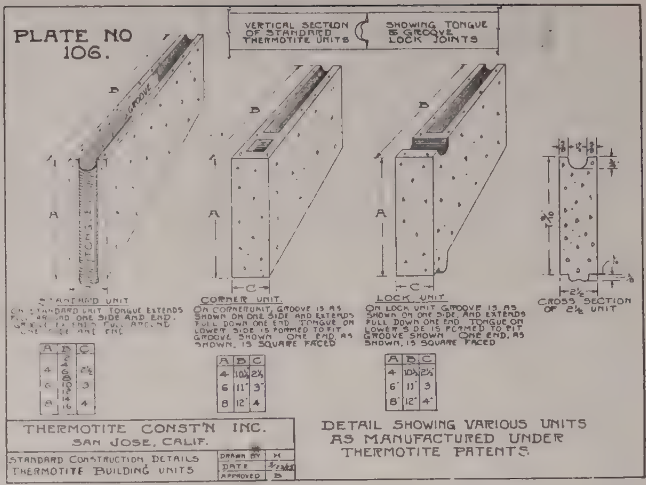


PLATE NO 106.
VERTICAL SECTION OF STANDARD THERMOTITE UNITS
SHOWING TONGUE & GROOVE LOCK JOINTS
GROOVE
A
B
C
STANDARD UNIT
ON STANDARD UNIT TONGUE EXTENDS FULL AROUND ONE SIDE AND END. GROOVE EXTENDS FULL AROUND ONE SIDE AND END
A B C
4 2 4 6 8 2½
6 10 12 3
8 14 16 4
CORNER UNIT.
ON CORNER UNIT, GROOVE IS AS SHOWN ON ONE SIDE AND EXTENDS FULL DOWN ONE END. TONGUE ON LOWER SIDE IS FORMED TO FIT GROOVE SHOWN. ONE END, AS SHOWN, IS SQUARE FACED
A B C
4 10½ 2½
6 11" 3"
8 12" 4
LOCK UNIT
ON LOCK UNIT GROOVE IS AS SHOWN ON ONE SIDE, AND EXTENDS FULL DOWN ONE END. TONGUE ON LOWER SIDE IS FORMED TO FIT GROOVE SHOWN. ONE END, AS SHOWN, IS SQUARE FACED
A B C
4 10½ 2½
6" 11" 3
8" 12" 4"
CROSS SECTION OF 2½ UNIT
2½
THERMOTITE CONST'N INC.
SAN JOSE, CALIF.
STANDARD CONSTRUCTION DETAILS
THERMOTITE BUILDING UNITS
DRAWN BY
DATE
APPROVED
DETAIL SHOWING VARIOUS UNITS AS MANUFACTURED UNDER THERMOTITE PATENTS

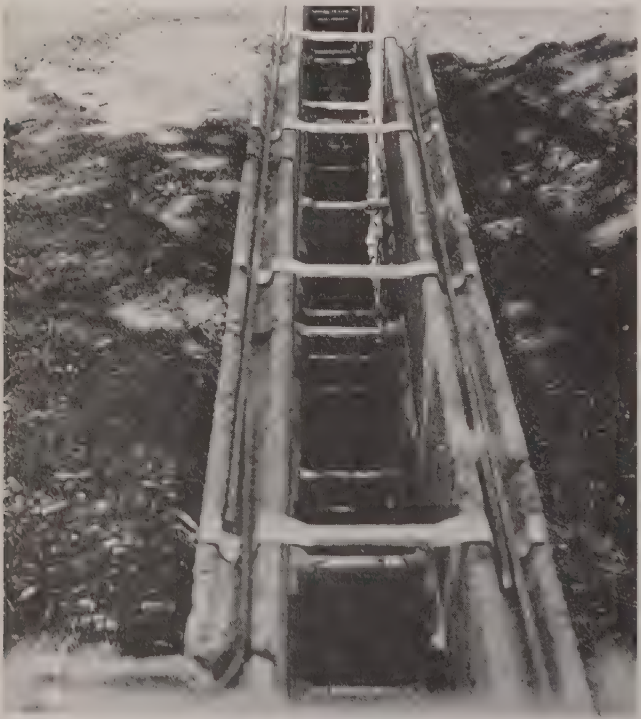
and end, while the other side and end is grooved to take the tongue of another unit. The tongue is grooved to take the reinforcing, which is inserted in the joints, and allow edges to close. The joints can thus be made almost unnoticeable, since the shoulders of the units are beveled inward to allow for the grout. The Corner unit has a groove, as shown, on one side and on one end, a tongue on the lower side, and one end is square faced. The Lock unit has a different tongue and groove arrangement, and a square end. The Column unit is practically the same as the Corner unit, except in dimension, and is made in one thickness only. The Paving unit is a plain slab with square faces, sides, and ends. It comes in one thickness, 1½ in., is 8 in. high, and comes in even lengths of 2 to 16 in.

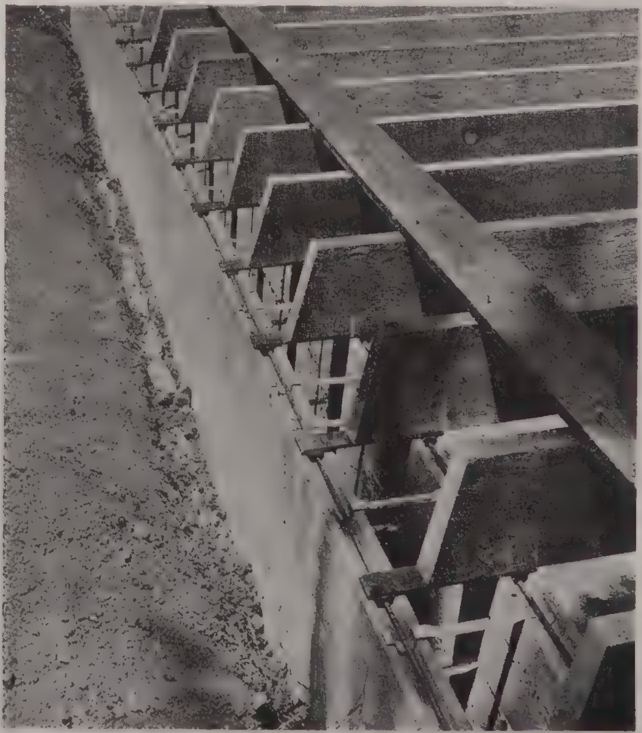
The system of construction, we were informed, is not that which calls for the services of a mason. The usual tools of that trade are not required, and common labor, after short training, can do a good job when supervised by an experienced builder. The procedure of erection may be described as follows:

On the foundation wall the first course, inner and outer, is laid in a bed of stiff grout, with the groove upward. The bottom tongues are removed to make this possible. This latter operation can be done at the work, or the plant will supply units for the first course as ordered. Diagonal reinforcing and ties, which are of flat galvanized metal and shaped on the ends to pass between tongue and groove, are laid up with the wall as shown. Horizontal and vertical joints are slushed and overfilled with grout, and the succeeding units are simply shoved into place, closing up the joints and squeezing out the excess grout, which can then be struck off with a stick or other tool.

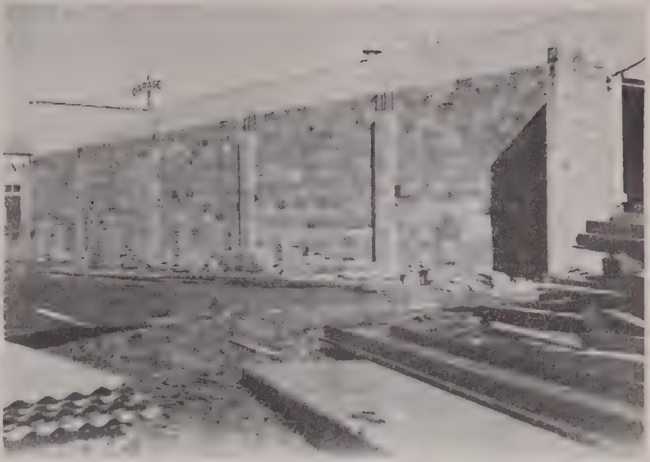
Line and Plumb

The walls are carried up by a unique arrangement that appears to have practical merit. The equipment consists


A view of wall in process of construction. Notice the cross ties, the horizontal reinforcing, and how the latter is self-centering. The groove is ready for the grout


This shows the way the floor joists are set in the wall. Notice the combination joist anchor and wall tie on which the joists are resting. The reinforcing is also shown

Abracadabra Fraternity House, University of California, Berkeley. Built of double 3-in. Thermotite walls with 17-in. air space between. Note heavy reveals at the windows. Lionel H. Preis, San Francisco, architect



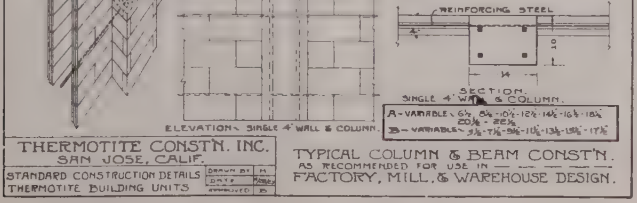
Building a structure using the units as forms for columns and beams, which are of reinforced concrete. Heavy industrial construction at a low cost

of an alignment rail supported by metal ratchets, which are secured to uprights, which are in turn set up, plumbed and braced, at not greater than 12 ft. intervals, in the same manner that a row of studding is set. Lengths of 2x4 lumber are just right for the rail and the uprights, while Clouser's concern is in a position to furnish the metal ratchets at a small cost. The units are laid up against the alignment rail, and the latter is raised one notch in the ratchets as each course is completed.

The reinforcing consists of the above mentioned diagonal ties and cross ties that tie the inner and outer section of the wall together and ¼-in. steel rods that are laid in the horizontal joints and run all the way around the structure. These rods are lapped at their ends in the usual manner and are bent to run around corners. An extra rod is laid to the corner in each case. The rods, which are installed about every fourth course, lie in the bottom of the groove and are put into tension by means of the grout. Since the tongue is recessed or grooved to account for the largest rod that might be required, this reinforcing does not prohibit the formation of a tight joint when the groove is completely filled with the grout. Extra reinforcing is provided over all openings and wherever otherwise considered necessary by the architect. Grout can easily be placed in the joints by pouring directly from an ordinary gasoline can or similar receptacle.

A Joist Anchor

The usual 2x8 floor joists are inserted in the wall quite the same as with any masonry construction. The ends of these joists are diagonally fire-cut to conform to the usual code. A special combination joist, anchor and wall tie is then nailed onto the bottom of the joist with a 16d. common nail and the joist is then set in position on top of the two rows of units at the desired level. The space between the joists on the inside wall is then filled in with the proper length unit and the succeeding courses are laid in the usual manner. Provision is made in the end tongue and groove of the units for the placing of a ⅜-in. bolt for the fastening of a wall plate.



Another unique feature is the method by which a frame joist and rafter roof is fastened to the wall construction. A 2-in. wood plate is laid on top of the wall and is bolted down to the wall by means of plate bolts embedded in the vertical joints. The roof joists are then secured to the plate, by the carpenters, in the usual manner. The plate bolts are ⅜-in. by 10½-in. and are spaced 4 ft. on centers alternating on each wall.

Standard box window frames and door frames are built in at the desired points by using the short length units necessary. Reinforcing rods can be bent and carried down through vertical joints when necessary in framing these openings. The frames can be so grouted into place that caulking is unnecessary.

These units may be used as well for veneering a frame building. In this type of work this 2½-in. reinforced concrete wall can be built around a frame building at no greater cost than sheathing and stucco. In new construction any size studding can be used by varying the depth of window and door frames to suit. For recovering old frame buildings the same methods are used, except that a slightly different tie is used for fastening the units to the structure beneath. In either case the units are tied

The molds in which the units are made are of bronze. This metal is said to give better service than steel to the studding or sheathing by means of special galvanized steel ties, these ties grouted into the joints between the units.

Industrial Buildings

In structures to be subjected to heavy loading a very simple and economical column-and-beam construction is available. This is suitable for factories, mills, warehouses, and so forth. Here the walls are laid up quite as usual, except that hollow columns are laid up as a part of the interior wall, to the desired dimensions. The horizontal reinforcing is carried straight through and across the open spaces provided by the columns. Special column units are used in laying the columns. Vertical column reinforcing steel is placed inside of these columns and the space then filled with poured concrete. At the same time reinforced concrete beams are poured between the two walls and monolithic with the columns. The inner and outer walls thus act as forms, while a galvanized iron sheet is laid up on top of the two walls to act as the bottom member of the forms. The result of this economical forming of a reinforced concrete skeleton structure is that all costs of form work are practically eliminated, and the hollow reinforced concrete curtain wall, built of the precast units, is securely tied into the frame of the structure by means of its own reinforcing. This construction complies with all codes and has been used with success and economy, we are informed.

A Stable Structure

It can be readily seen from the foregoing description that a building of this type with double wall, adequate reinforcing and log-cabin corners should provide ample stability, a high degree of permanence and marked livability. Some unique architectural effects can be cheaply obtained by constructing an extra thick wall with deep reveals, by eliminating cover and selecting tile of miscellaneous colors, and by laying up the exterior with units of several different thicknesses. We were informed that an immense church is to be built by this system in a western city. Unusual architectural effects are to be gained in this particular work.

The company exploiting this new system of construction, known as Thermotite Construction, Inc., 390 Stockton Ave., San Jose, California, is now operating a successful plant in that city. Their special tamping machines are used together with the bronze molds in turning out a high quality product. The units as taken off the machine are loaded unto racks and transported in the plant by means of Steubing lift trucks. The capacity of each rack is 74 units. Units are delivered to the jobs by motor trucks when within a 50 mile radius of the plant. In organizing new plants, this concern writes into their contract a strict clause to the effect that A. S. T. M. requirements must be met in manufacturing Thermotite units. By this means and through the cooperation of the parent corporation, a high standard of quality is to be maintained.

Work of this class is being done successfully and profitably by experienced organizations at a price that will compete favorably with frame.

Test Road Section at Bry-sur-Marne, France

By M. FOURNIER*

This road section, built by the "Society for the Study of Concrete Roads" in France, begins at Bry-sur-Marne, Seine Department, and extends 1106 meters to the boundary line of the Seine-et-Oise Department.

No reinforcement was used. The existing stone pavement was used as foundation. The tests were to show the effect of:

1. Consistency
2. Method of finishing
3. Expansion joints
4. Sodium chloride in the mixing water on shrinkage of concrete.

The coarse aggregate consisted of porphyry and limestone, graded 5 -40mm. The Seine sand was graded 0 to 5mm. A standard portland cement was used.

Dry Mixes: The cement content was 350 kg. per cu. m. of concrete. The quantity of mixing water was controlled automatically and could be adjusted for each batch in accordance with the properties of materials. It varied from 25 to 32 liters per cu. m. of concrete.

The thickness of the finished section was .15m. Expansion joints were spaced 15 m. apart in sections 1 and 4. (See Outline.)

Wet (Plastic) Mixes: An American mixer was used with automatic control of mixing water. The quantity of the latter varied from 46 to 68 liters per cu. m. of concrete. A Lakewood machine was used for finishing sections 6, 7, 8 and 11. (See Outline.)

OUTLINE

Section No.	Consistency	Machinery	Aggregate	Mixing Water	Joints	Length meters
1	dry	pneumatic tamping	porphyry	fresh	joints	106
2	dry	pneumatic tamping	porphyry	fresh	none	100
3	dry	roller	porphyry	NaCl	none	100
4	dry	roller	porphyry	fresh	joints	100
5	dry	roller	porphyry	fresh	none	100
6	wet (plastic)	Am. machinery	porphyry	fresh	joints	100
7	wet (plastic)	Am. machinery	porphyry	fresh	none	100
8	wet (plastic)	Am. machinery	porphyry	NaCl	none	100
9	wet (plastic)	hand finish	porphyry	fresh	joints	100
10	wet (plastic)	hand finish	porphyry	fresh	none	100
11	wet (plastic)	Am. machinery	limestone	fresh	none	50
12	dry	roller	limestone	fresh	none	50
Total						1106 meters

The road had a width of 6 meters and a curvature of 1/70.

Work was begun in May, 1924, and was practically completed by July, 1924. It was opened to traffic in August, 1924.

Tests: Aside from the practical experience gained on the job, laboratory tests are being made on samples taken from the mixer and placed in cube molds, and of cores, .10m. in diameter, taken from the finished road section. These tests are being made at the Materials Testing Laboratory of the City of Paris. Statistical data of the traffic are being recorded. The deformation of the road section is being checked by frequent leveling.

Scrap Lumber for Forms in Costa Rica

Concrete forms in Costa Rica are so very light that small dimension, low grade, and generally second-hand lumber has been found adequate for the purpose, states Vice Consul Roderick W. Unckles, San Jose, in report to Department of Commerce. The low grade lumber used for forms and shoring comes from the native forests, is sawed locally, and may be purchased for very little money. Where boards from cases, such as those used for packing large window glass are used, the cost of forms is reduced to a minimum.

The construction of reinforced buildings or other concrete work is extremely occasional in Costa Rica. Furthermore, such work of this nature as has been done in this country in the past has invariably been light weight, and none of the very few buildings constructed have been over two stories in height.

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*Abstracted from "Le Ciment," No. 8, August, 1925, by M. G. Arronet.

Test of New Wall Indicates Stiffness

Samson Type of Concrete Wall Construction Tested by Columbia Testing Laboratories, and Found to Possess a High Degree of Lateral Stiffness Under Heavy Loadings

Many problems relating to concrete construction are solved only after research work and elaborate tests have been conducted and the behavior of the structures observed under conditions or loadings similar to those actually met under working conditions.

Much valuable research work has been done, and is being done, by the U. S. Bureau of Standards at Washington, D. C., and in its branch laboratories maintained at different points throughout the United States. The investigations of the Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill., have resulted in valuable data in numerous lines of concrete construction work, particularly in the control of the quality of concrete. Other independent laboratories have done valuable work in testing various types of construction and in giving unbiased reports of the test results.

Extensive tests of crushing strength and fire resistance of various masonry materials and combinations were conducted by the Bureau of Standards and at other places as a preliminary to the report of Secretary Hoover's committee, on the subject of minimum requirements for masonry wall construction. Further tests of special types of construction as referred to in the following report of a test at the Columbia Testing Laboratories are valuable for their supplemental data.

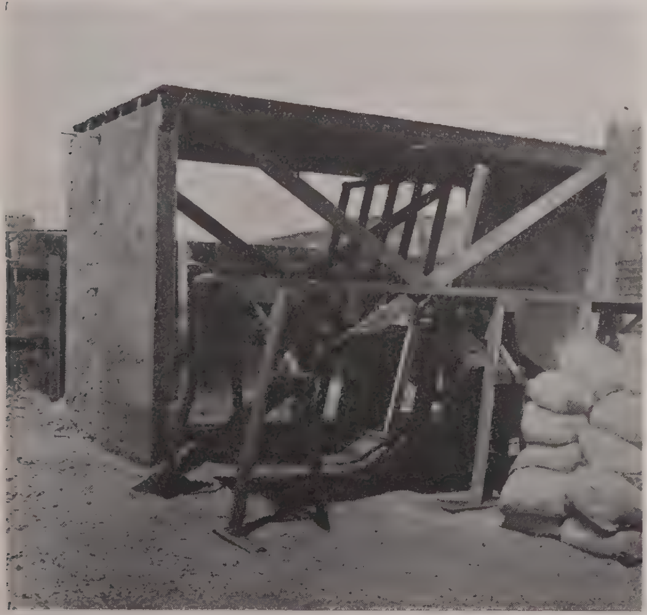


Fig. 2—Photographic view of hollow stud partition with mortar finish applied with the Oliver Mortar Gun

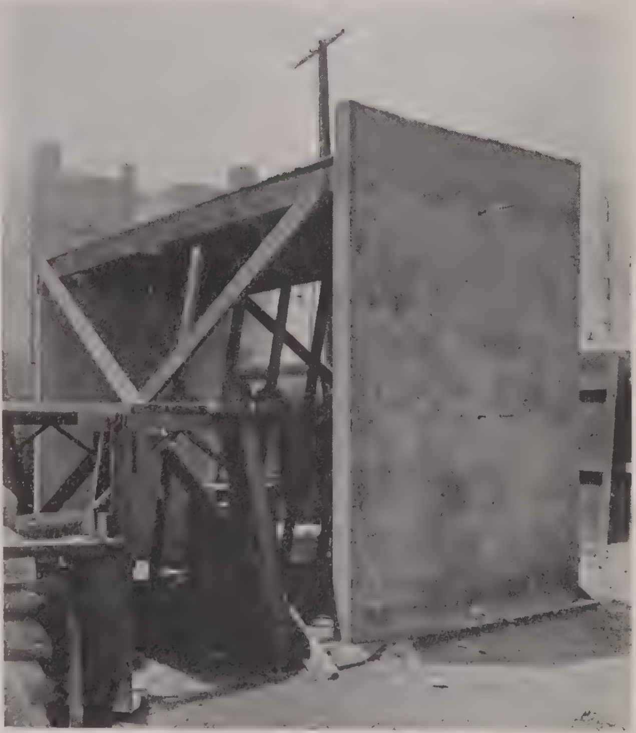


Fig. 1—View of solid 4 1/2-in. wall constructed with the Oliver Mortar Gun

The test by Columbia University Testing Laboratories of a structure consisting of two walls each 7 ft. long and 8 ft. 6 in. high spaced 15 ft. in the clear and supporting a wooden floor, gave some interesting results for the reinforced mortar wall known as the Samson wall. One of the supporting walls was a $4\frac{1}{2}$-in. Samson wall and the other was a timber stud partition. Under a loading of 1153 lbs. per ft. of wall, the Samson wall showed a lateral displacement at mid-height of the wall section of 0.05 in. On the hollow partition a load of 602 lbs. per ft. of partition produced a maximum displacement of 0.02 in. at the center or mid height.

The structure mentioned above was erected on April 17, 1925, at the plant of Albert Oliver & Son, Inc., Bronx, New York, and tested on June 10, 1925. The loading test was supervised by the Testing Laboratories of the Department of Civil Engineering, Columbia University. The installation and test of the structure were witnessed by representatives of the Bureau of Buildings of the city of New York. The description of the test structure as reported to the Columbia Testing Laboratories is as follows:

The test structure consisted of a $4\frac{1}{2}$-in. reinforced mortar wall 7 ft. long and 8 ft. 6 in. high and a timber stud partition of the same height and length, to which mortar, approximately one inch thick, was applied on both sides. The wall and partition were erected on 12 x 12-in. mud sills and supported six 3x8-in. spruce floor beams 16 in. on centers covered with $\frac{7}{8}$-in. sheathing as shown in the accompanying illustrations. The wall and partition were parallel and spaced with a clear opening of 15 ft. This construction was intended to represent sections of an outside building wall and an inside partition supporting a floor. Photographic views of the test structure are included. Fig. 1 is a view of the wall taken before the test and Fig. 2 is a view of the partition wall before test.

Samson Wall

The reinforced mortar wall was constructed by depositing 4½ in. of portland cement mortar on Samson Soundproof Partition material by means of the Oliver Mortar Gun. The reinforcement consisted of ⅜-in. round rods spaced 8 in. on centers, vertically and 24 in. on centers horizontally, electrically welded at the intersections. This reinforcement was placed approximately one inch from the finished outside surface of the wall (3½ in. from the patent partition material). The inside of the wall was finished with cement mortar deposited on the partition material to a depth of approximately ⅞-in., thus producing a wall having a total thickness of 5¾ in. The Samson Partition material referred to was composed of two layers of Johns-Manville double Neptune Hair Insulator with 1 in. poultry netting on each side. A 4x16-in. galvanized wire mesh, having No. 8 gauge vertical wires 4 in. on centers and No. 10 gauge horizontal wires 16 in. on centers, was applied to one side and suitably tied to ¼-in. diameter vertical rods spaced 8 in. on centers on the other side.

A 3x3x3/16-in. angle, 7 ft. long, embedded in the wall, served to distribute the floor beam loads. The mortar deposited as described above was mixed in the volumetric proportions of one part portland cement, three parts sand and one-tenth part hydrated lime with water to produce a workable mix.

Hollow Partition Wall

The hollow partition which supported the other ends of the floor beams was composed of 2x4-in. studs, 16 in. on centers, bridged at the mid height. Double 2x4-in. plate and sill were provided. Both the inside and outside of this partition were covered with mortar, approximately ⅞-in. thick, deposited on Samson Sheathing, composed of felt and 3¼x6-in. woven wire mesh. The total thickness of this partition was 6 in.

Method of Test

The floor covering an area 7x15 ft. was loaded with bags of sand, having a total weight of 8428 lbs. uniformly distributed, corresponding to a load of 80.2 lbs. per sq. ft. The total load on each wall under this loading was 4214 lbs. or 602 lbs. per ft. of wall. Observations to determine the lateral deflection of both the wall and partition while supporting the load were made by means of two engineer's transits directed toward the horizontal scales attached to the wall and partition at the top, mid-height and bottom along a vertical center line.

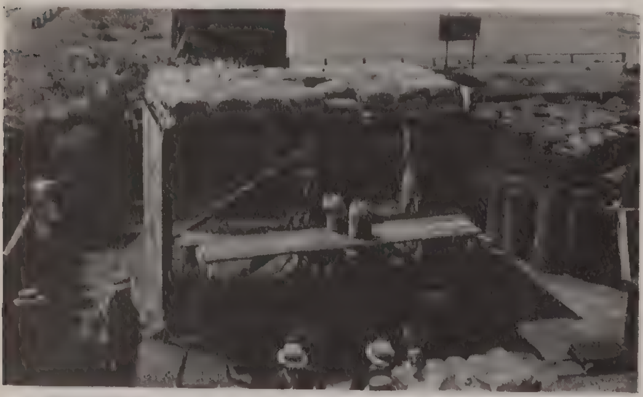


Fig. 3 View showing the superimposed load of 8428 lbs. corresponding to 80.2 lbs. per sq. ft. of floor area applied to the test structure

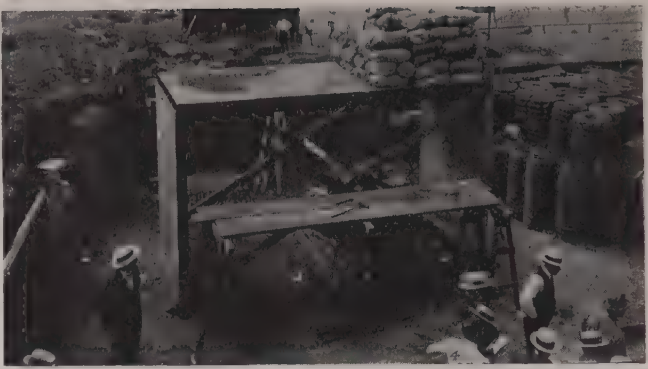


Fig. 4—View showing the superimposed load of 9702 lbs. applied over one-third the floor span producing a wall reaction equivalent to that of a uniform load of 154 lbs. per sq. ft. of floor area

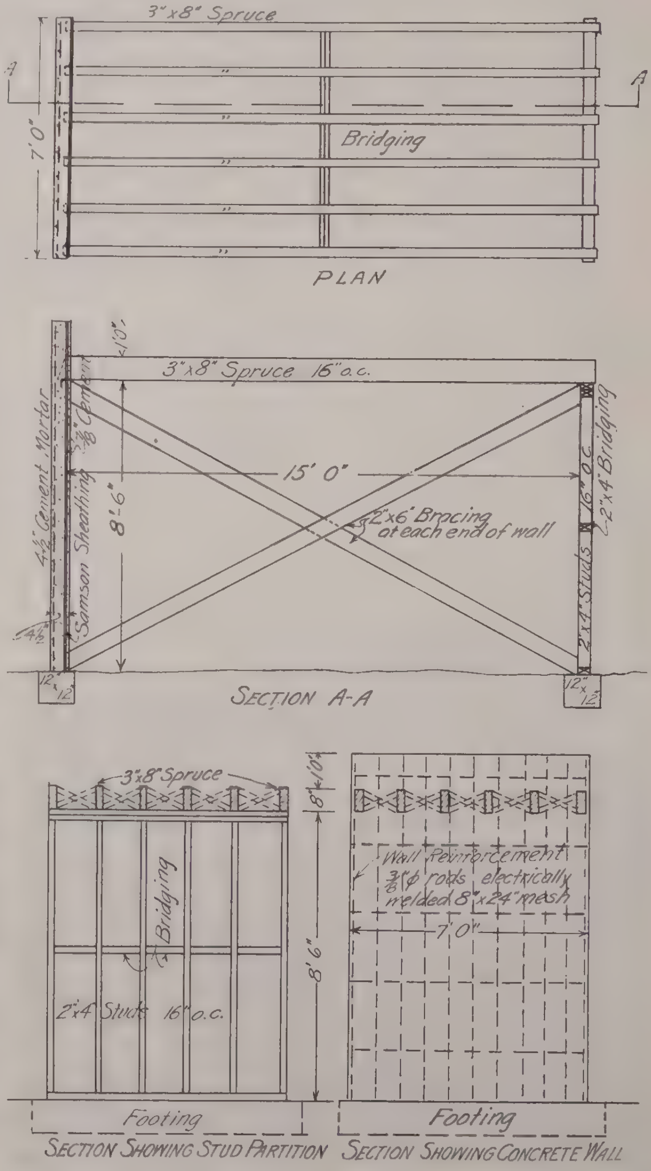


Fig. 5—Sketch showing plan and sections of concrete wall built with the Oliver Mortar Gun and subjected to load test

Fig. 3 is a view of the test structure supporting a sand load corresponding to 80.2 lbs. per sq. ft. of floor area.

Following the above test, bags of sand having a total weight of 9702 lbs. were distributed over one-third the span, adjacent to the wall, i. e., over an area of 7x5 ft. adjacent to the solid wall. This distribution resulted in a wall reaction equal to five-sixths of this total load; namely, 8085 lbs. or 1155 lbs. per ft. of wall. The load thus brought upon the wall was equivalent to that which would be produced by 16,170 lbs. uniformly distributed over the entire floor area corresponding to 154 lbs. per sq. ft. of the 7x15-ft. floor. The later deflection of the wall was observed while supporting this load. Fig. 4 is a view of the test structure with a final load in place.

Results of Test

The following tables give the observed displacements of the wall and partition while supporting the loads as described:

LOAD TEST OF SOLID WALL

Total load applied to structure lbs.	Total load applied to wall lbs.	Load per foot of wall lbs.	Equivalent floor load lbs. per sq. ft.	—Lateral displacement— bottom	center	top
4214	2107	301	40.1	0	0	0
8428	4214	602	80.2	0	0	0
9702	8085	1155	154.0	0	.05″	.06″

LOAD TEST OF HOLLOW PARTITION

Total load applied to structure lbs.	Total load applied to partition lbs.	Load per ft. of partition lbs.	Equivalent load on floor lbs. per sq. ft.	—Lateral displacements— bottom	center	top
4214	2107	301	40.1	0	.02	.02
8428	4214	602	80.2	0	.02	.04

The scales used for the above observations were graduated to .02-in. and readings were estimated to 0.1-in.

The equivalent load on the floor was computed on the basis of the 7x15-ft. floor provided.

No cracks or distortions other than those recorded were observed during the test. The displacements recorded indicate an outward bending of the wall producing a center deflection of .02 in. at the maximum load applied.

Modern Coal Bunkers in German Power House

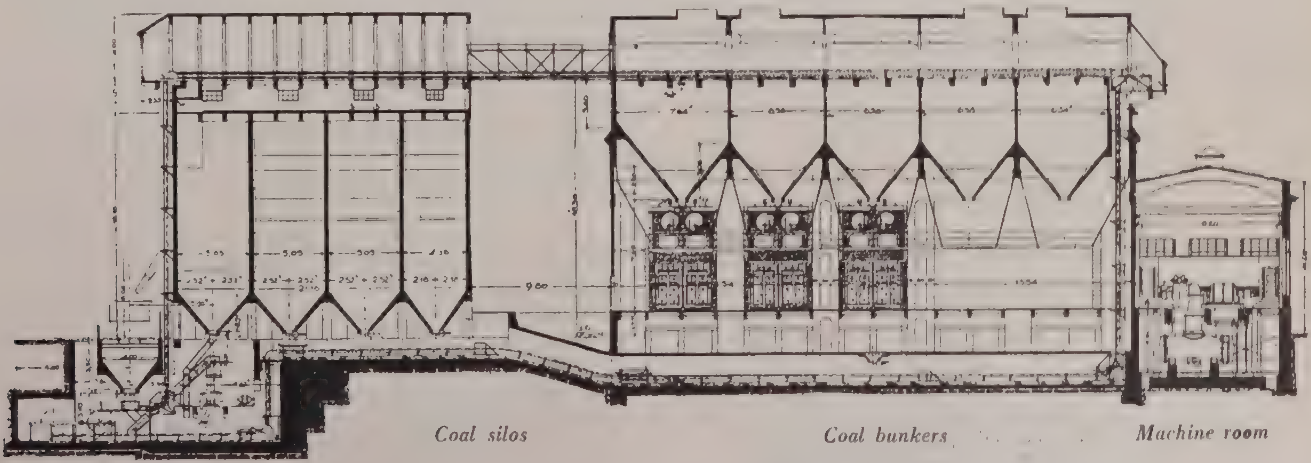
By K. SEYTTER*

The illustrations show the up-to-date design used in the new power house of a cotton mill in Germany. The storage silos, bunkers, power house, etc., are of reinforced concrete throughout. Difficulties were encountered in the design of foundations for silos without encroaching upon the adjoining factory building. The ground water level being 6 meters above the bottom of the discharge pit, heavy pumping was necessary. A smooth finish and a tar coat were relied upon to make the concrete impermeable.

With regard to fire prevention, it was considered best to depend upon the density of the silo walls and to exclude contact with air at the feed and discharge ends.

View of the completed boiler house

The building operations were carried out without necessitating shutdowns of the mills; this introduced unusual temporary conditions of loading, making it necessary to raise the allowable stresses in exceptional cases to $f_c =$ 60 kg. per sq. cm. (750 lb. per sq. in. and $f_s = 1300$ kg. per sq. cm. (18,500 lb. per sq. in.)



Longitudinal section

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*Abstracted from Beton und Eisen, No. 17, September 5, 1925, by M. G. Arronet.

How, What, Where, and Why?

"Please give me information as to where I could get a real bright sparkling facing material that will not hair crack, in gold or silver color. I want to use this material for an ornament for a grave lot."

G—— R——,
Pinckneyville, Ill.

We might suggest that you try mica flakes as a facing material. This mineral is widely used by products manufacturers, and even by stucco contractors to give a real sparkle to their material. It usually comes in a silver tone, but we have seen some that appears to have a golden tint in some lights and some that even verges on the gray, but the material that would give you gold tones might be in the form of iron pyrites, although we do not know of any source for this material in a separated state.

It is usually associated with certain ores or rocks in the form of small flakes and crystals, and might be utilized by obtaining a supply of pyrites-bearing rock or ore and using the crushed material just as it happens to run.

Possibly, we could obtain a source of supply for this material or a sample if you would like to look into it further.

"Can you supply us with authentic data regarding filling cracks in concrete walls or chimneys with the cement gun?"

A. D. P——.
Worcester, Mass.

We are of the opinion that cracks in concrete walls and concrete chimneys can easily and profitably be repaired with the cement gun. The services of a contractor, who is trained in the use of this device, should be secured, if possible.

All that is necessary in making repairs of this kind is that cracks be opened and cleaned out by means of a cold chisel, dust blown out by compressed air or other means, the cracks thoroughly wet down with a hose, and the concrete sprayed into place.

In some instances, it might be necessary to work the concrete into the cavity with a trowel or other hand tool. In case a large patch is necessary, special finishing methods might have to be used.

In order to avoid trouble in making these repairs, at your plant, why not call in a contractor or structural engineer?

"I am in a position where information is greatly needed. Will a concrete floor 16x73 ft. that is rough and has small holes, if resurfaced 2 in. thick, prove satisfactory to owner? How can this be done to be a satisfactory job, where a lot of trucking is done?"

N. J. S——,
Arlington, N. J.

We are not certain that it would be wise to try to patch that concrete floor, unless you are absolutely certain that it rests on a secure foundation. If the soil or fill underneath the floor is not thoroughly compacted and even, any patching that you might do might prove but temporary.

If the floor is in an extremely bad condition, it would be cheaper at any rate to tear it up and put in a new one, but if the holes are few and far between, possibly, it would be all right to go ahead putting in your patches. In doing this latter operation, it would be best to chip out the bad spot clear down to the fill and make sure that this underlying material is compacted sufficiently to stand up under the load.

Make sure that adjoining edges are roughened up with a cold chisel or pick, thoroughly wetted down with a hose, and slushed with a neat cement grout before applying the patching material, then dump in your new concrete and tamp it well into place, keeping it thoroughly wetted down until it has hardened. This might then make a patch that will stand up for a while, although it will probably be noticeable.

We hardly think that a two-inch surfacing on the old floor would prove satisfactory under factory conditions, although it might be all right if the underlying material is first rendered sound, and then the old surface carefully cleaned, roughened, and wetted down.

If you are going to all this trouble, why not give your client an entirely new floor and put it in right to begin with?

"What kind of metal does not stick to concrete?"

M. M——,
Euclid, Ohio.

Steel forms are used almost universally in concrete work of various kinds and the only step that is necessary to keep them from sticking to the concrete is to wipe the forms occasionally with oil before using. You will then find they come off clean and without trouble.

Oil for this purpose should be mixed fourteen parts kerosene and one part light lubricating oil. If this mixture is properly made, it will evaporate, leaving no stain.

If you are to be still more particular, you can wipe your forms with a soft soap solution, lard oil or paraffin oil. These are especially to be used where all danger of staining must be avoided. You will thus be able to use steel forms as everyone else is doing and not have to go to the trouble of making glue molds or other devices.

"We are about to erect a fireproof warehouse for the housing of our masonry supplies, and thought perhaps you might be willing to give us a few pointers on the construction part of it.

"We desire to have the floor about on a level with the floors of the cars, and are therefore wondering if we fill in the necessary depth which is between 3 and 4 feet with cinders, etc., and then lay a concrete floor if there would be enough dampness to harm the lime, plaster, etc.

"If the above construction does not appeal to you, then just what floor construction would you use? Any information you have on this will be greatly appreciated."

B—— & W——,
Cortland, N. Y.

We believe that your idea of a concrete floor on a cinder fill would be quite satisfactory for use in your new building, if the following pointers were borne in mind: You may find that clay, brick-bats, or other material would be a little cheaper than cinder for your fill, and that at least a couple of feet on the bottom would be all right and might save you a little money. However, if you find that cinders are just as cheap, they will make the finest kind of filler.

It might be advisable to lay several lines of drain tile underneath the floor and leading to the outside. This tile, being well toward the bottom of the cinder fill, ought to take care of any water that tries to work its way up to the floor. The cinders should be well compacted and settled before the concrete is laid, and a fabric reinforcement used in the concrete slab so as to provide strength in case the cinders should settle in spots.

If you plan to have a loading platform outside your structure, the attached sketch will indicate to you a type of construction that would prove permanent and economical. (Not reproduced.)

We would advise the application of a standard floor hardener and waterproofing to the storage floor in order to overcome the slight amount of dampness that might otherwise be found at certain seasons of the year.

Poles for Overhead Lines

A Steel and Concrete Construction Being Used in Australia With Some Success

By MAJOR JOHNSTONE-TAYLOR
Fiddlers Ferry, Warrington, England

In Australia in common with other new countries distribution of electrical energy is largely made commercially possible by constructing the subsidiary transmission lines as cheaply as possible commensurate with durability. These conditions appear to be well met by the Stobie steel and concrete pole, the essential features of which are two light standard steel joint or channel sections which form the outside tension and compression members. These are, as will be seen, exposed on one side and are therefore open to criticism on the score of corrosion in the same way as steel poles are, but the exposed surfaces are relatively small and very easily coated with composition which will last several years. These steel members are held in position and at their proper taper by bolts and the elongated triangular space so formed is filled with cement concrete. This concrete filling when set forms a continuous web in which the aforementioned bolts are embedded and incidentally take a portion of the shear stress. The resultant pole is very rigid and has considerable resistance to any torsion which may arise from unbalanced pull. Bolt holes for the attachment of the cross arms are cast in the concrete at the time of pouring and it is usual to fit these cross arms and their insulators before the pole is raised into position. This method of construction has proved very suitable when the transport of heavy members would be difficult as the individual sections are relatively light and the concrete work which is of the simplest does not call for any special machinery or skilled labor. The completed pole can when necessary be transported over very rough ground without suffering any damage. For poles of an average length of 42 feet the steel members are composed of two 4¾ in. by 1¾ in. R. S. J's as shown in Figure 1, the connecting bolts being spaced as shown. The bottom width is 15 inches, a gradual taper being maintained to the top where the steel sections abut. The actual work involved therefore is merely that of bolting together the sections, fixing the moulds which are shown in Figure 2, and pouring the concrete. The latter is allowed 14-21 days to set and season.

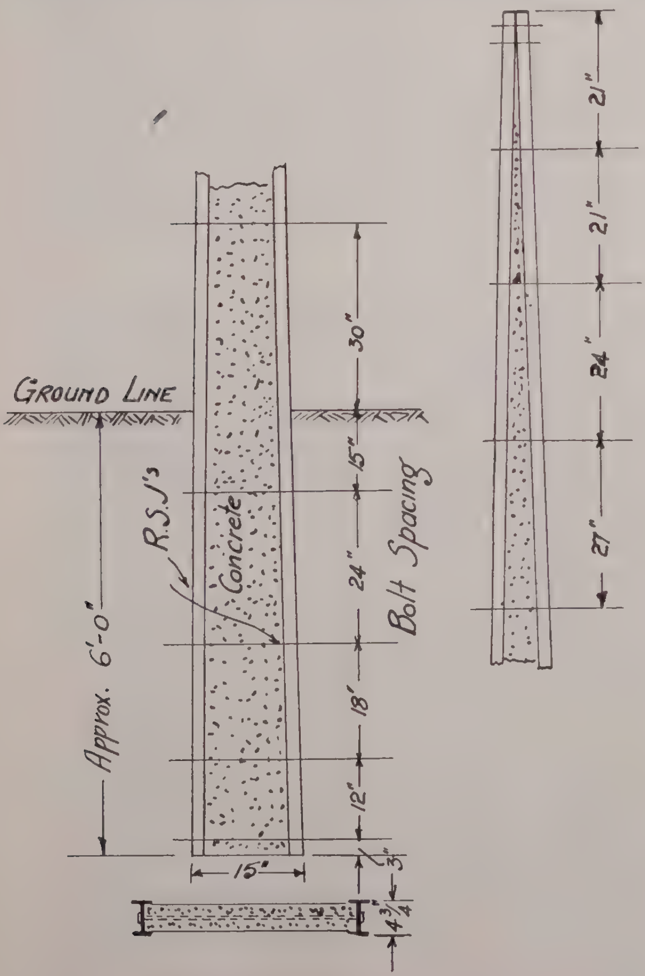


Fig. 1—General dimensions and characteristics of the pole

Strength

The actual construction will be seen to be simplicity itself and need not be dilated upon, it being the business of those in charge of the work to plan out the actual work to ensure it being done as cheaply as possible with due regard to local conditions. Strength, however, is an important matter in a transmission line support. It is not possible here to analyze the loads on poles of this class which are now well understood but it will be obvious that the weight of the cables plus wind stress and ice loading if the last named has to be provided for, produce a pull on the pole. Under normal conditions the pull of the line on one side balances that on the other, but if the lines break then the pole becomes a cantilever of considerable length, loaded relatively near its end. The strain may under such conditions be considerable. For instance, under the usual conditions of spacing, loading and allowable sag in the conductor of a small three phase line there would be an approximate maximum load of 630 lbs. at about 33 feet above ground, which would set up a stress of approximately 15,000 lbs. in the steel members or about one quarter of their ultimate strength. Actual tests in the field designed for a load of 500

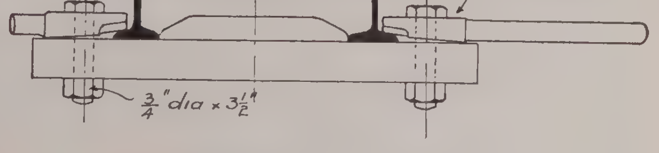


Fig. 2—Molds for making the poles

lbs. failed to cripple a pole at 1,300 lbs. and at the designed load there was no permanent set. At the maximum load applied—which it might be noted was limited by the failure of the steel pole against which the load was applied the concrete pole took a permanent set but showed no sign of fracture.

The following particulars are given of poles now being made and erected:

Length. Feet	29	36½	42½	47½
Load allowed for one foot from top. Lbs.	500	500	550	1570
Weight of Steel. Lbs.	290	365	553	1140
Cubic feet of Concrete	3.7	4.52	10	14.5
Total weight. Lbs.	825	1010	1970	3212
Approximate Cost	£3 15	£4 10	£7 5	£12 10

American Construction Council Fights Jerry-Builder

The prevailing theme of the Fourth Annual Meeting of the American Construction Council, which was held at the Congress Hotel, Chicago, November 18 to 21, was the eradication of the jerry-builder, and ways and means to give the public desirable and permanent housing at a low cost. This meeting, which was attended by representatives of contractors' organizations, architectural societies, realty firms, financial institutions, and material men's organizations, and by many individuals interested in Better Buildings, was devoted to papers and discussions on the subject of craftmanship, materials, construction methods, financing, design, planning, and the many things that effect the cost of any man's home.

The first session included discussions on the responsibility and the part played by architects, material men, contractors, labor, and apprentices, in obtaining better homes for less money. These discussions were led by such men as N. Max Dunning, Chicago, Eli B. Felsenthal of New York; D. F. Holtman, of Washington; O. W. Rosenthal, of Chicago; Edward Haupt, of Chicago; Wm. J. McSorley, of Cleveland, and Gerhardt F. Meyne, of Chicago.

After a luncheon, at which speakers of importance were guests, the matters of craftmanship and city planning were discussed by men of prominence.

The Thursday morning session was devoted to the financial aspects of better building. The afternoon session was given over to papers on the better building of homes. Here were discussed the Limited Dividend Corporation plan, as tried out at Sunnyside, L. I., the Safeguard Policy plan, the Better Home movement, better building from the building official's standpoint, better building and civic development, fire resistive construction, and the work of the Underwriters Laboratories.

A dinner was held on Thursday evening, under the auspices of the Chicago contractors, at which the problems

Building Trades Employers Meet to Discuss Labor

An interesting conference on present labor conditions throughout the country was recently held in Chicago, under the auspices of the National Association of Building Trades Employers. Delegates from local organizations of importance were present, and each one reported upon conditions in his own section. Conditions in open shop and closed shop cities were described by contractors from each.

The reports seemed to point out that 1926 building will be slightly less than in 1925, and that the supply of skilled men in most trades would be ample to supply the needs. No justification for changed wages was seen, while the employers took a firm stand opposing the five hour day. The apprenticeship situation was discussed at length.

The delegates were, as a result, enabled to return to their homes with a clear idea of conditions that would govern the formation of new agreements for the coming year.

They Don't Wreck Concrete Buildings, —But Move Them

When a property owner in Lansdowne, Pa., decided to erect a large building on his land he had to do something with a four story reinforced concrete structure that was already standing on the site. If it had been of frame or brick, possibly it would have been wrecked, but since the wrecking of so strong a structure would have proven more expensive than moving to another lot, the owner decided on the latter course. So this 50,000 ton structure was pulled several hundred feet to a new lot around the corner, and given a new lease on life. According to reports, absolutely no damage to the building itself, or to the street that it traversed, was incurred. The illustration shows two interesting views of the moving.

International Newsreel Photo

New Concrete Hotel for Argentina

A concession has been granted for a new resort hotel to be located at Playa Chica, in Mar del Plata, Province of Buenos Aires, by the Provincial Government and confirmed by the National Government, the Department of Commerce is advised by the American consulate at Buenos Aires. The project comprises the construction of a large and thoroughly modern hotel, with large ocean frontage, containing 400 to 450 rooms with baths, toilets, ball room, dining room, etc. Construction is to be of portland cement and brick work, the building to be of three floors and basement with terraces. There will be tennis courts and fields for other games. A large garage will be constructed for the accommodation of patrons' motor cars and for the automotive equipment of the hotel. It will be a self-contained hotel, closely patterned after those now existing in Atlantic City, New Jersey, and will provide its own electric light and power, water, refrigeration, etc. The complete hotel calls for the expenditure of some $1,322,944.

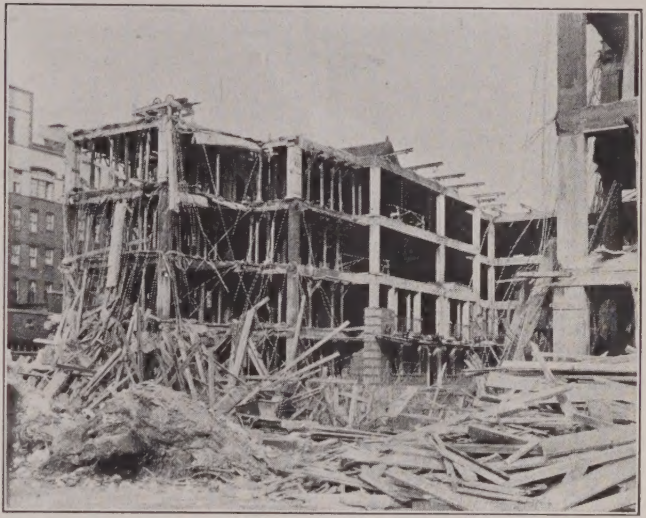
A subvention of 10,000,000 pesetas (present value peseta approx. $0.15) has been granted by royal decree for further construction of the East Mole of the port of Santa Cruz, Teneriffe, according to Consul Raleigh A. Gibson, Teneriffe.

Thus Are We Judged!

The Recent Collapse of a Reinforced Concrete Structure Brings Home the Importance of Real Protection Against Low Temperatures—Freezing Weather Not Necessary to Retard Setting—Affairs Like This Are Destroyers of Public Confidence

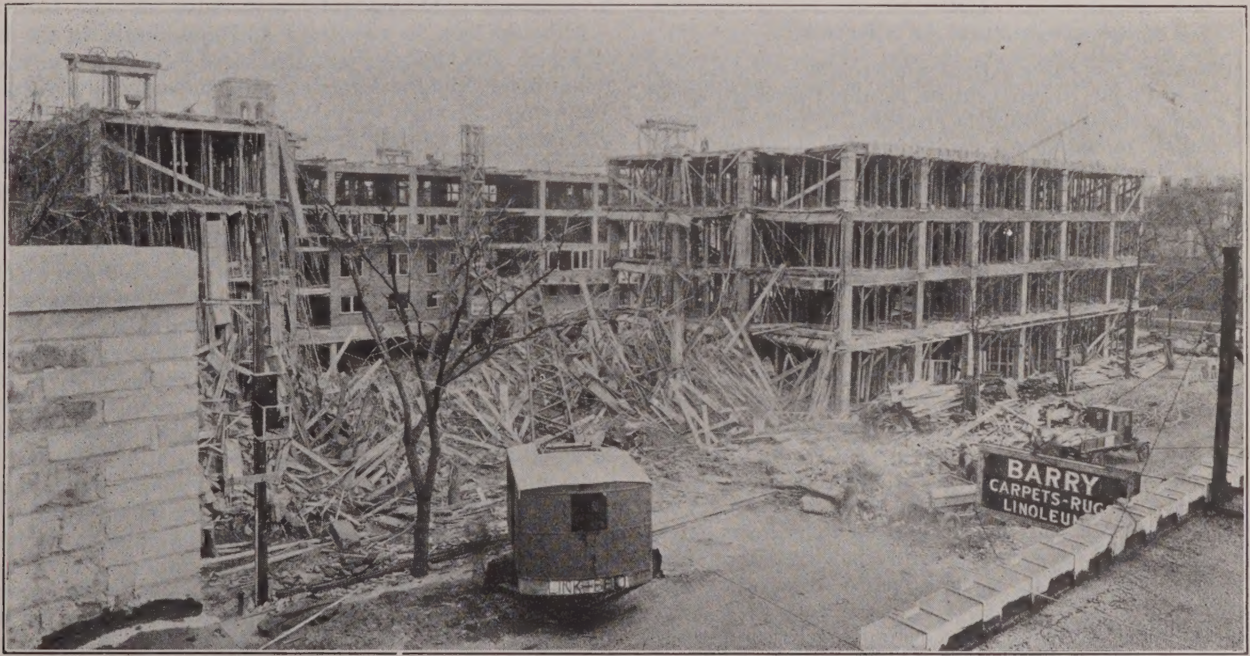
The collapse of a portion of a reinforced concrete apartment house, under construction in Evanston, a suburb of Chicago, has done a great deal to destroy public goodwill that has been built up by long years of constructing concrete structures that are the pride of the community. While the event was caused by a total disregard, it is said, of certain wellknown rules of construction, yet the public was given the erroneous idea that concrete construction is not safe. That was one result of what happened.

The other result is that it gives a good object lesson for others who may not have previously realized the fact that low temperatures, while above freezing, can seriously retard the setting of concrete.



A closeup of the structure, indicating the way the bays were torn away from adjoining ones, leaving the bars stripped clean

About 2:30 P. M., on November 3, several bays of a four story reinforced concrete building collapsed. In the portion wrecked, the roof slab had just been poured within the past few days. The failure, which followed removal of centering and floor forms by a short time, wrecked a section four stories high and approximately ninety feet by fifty-five feet in area. On this particular section of the job the first floor slab had been poured about 27 days previously, according to the builder and others on the job. The balance of the work had followed in short order. Lack of even the ordinary records on the job made this, and other matters, a matter more of deduction than of actual fact. The building specifications, upon which the permit was granted, called for a 1:2:4 mix, while the design and the system of reinforcing was strictly according to the code. Designing, which was apparently correct, had been done in the office of the builder. This concern had previously erected other structures of the same kind, none of which had given any particular amount of trouble, as far as could be learned. It is said that a steel tower, used in raising buckets of concrete, had fallen over a short time before on this job, because the builder had neglected to guy it properly.



This failure has given a lot of people an erroneous idea of the stability of concrete construction. It could have been easily avoided by adequate protection

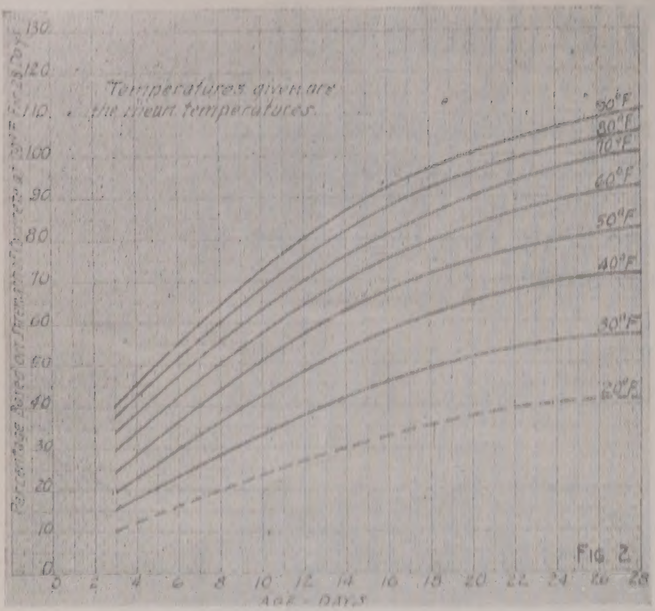


FIG. 2

This chart, taken from a recent laboratory report, indicates the rate of setting of concrete under different temperatures. It, alone, explains this failure

Setting Was Retarded

When the job was visited by the representative of CONCRETE the work of cleaning up had already begun, but close observation, and reference to available records, together with the statements of the men on the job and others on the spot, brought a number of interesting facts to light. The first fact was that the average daily temperatures read a few blocks away every four hours during the period of that part of the concreting operations were as follows, according to the United States Coast Guard Station:

Midnight	39.5	degrees	Fahrenheit
4:00 A. M.	36.7	"	"
8:00 A. M.	39.5	"	"
Noon	45.0	"	"
4:00 P. M.	44.8	"	"
8:00 P. M.	41.1	"	"

Average temperature, 41.1 degrees

Under such conditions, it is known that concrete can only obtain about 70 per cent of its rated strength at 28 days, except when the work is protected to such an extent that summer temperatures and moisture conditions are maintained by artificial means. Although the builder claimed that he had given the job such protection, yet observation pointed to the contrary. The behavior of concrete under adverse temperatures is shown by the accompanying curves. They represent strengths that are obtained when all other factors are favorable.

Unusually Low Strengths

Comparing the chart with the facts in this case points out that, other conditions being favorable, the concrete on the failed first floor slabs and columns could not have gained more than sixty-five to seventy per cent of the normal 28 day strength, or a possible 1,400 pounds on the upper floors. In the basement, conditions for curing were still less favorable, and it is estimated that the concrete in that portion of the structure could hardly have gained as much as 800 lbs. in strength before the forms were stripped.

The slab that first failed, according to observations of the engineers who investigated the affair, was seriously overloaded by a quantity of partition tile that had just been delivered.

Perhaps Other Factors

Other observations point to the fact that a much drier mix could have been used, and that aggregates obtained on the site, which may not have been of good quality, may have been utilized on this part of the structure. Laboratory reports indicate that the concrete is of fair quality, and that the presence of low temperatures, with the consequent retarding of set, are sufficient to account for the failure.

Because of the fact that adjoining bays were somewhat deflected as a result of the failure, particularly on the roof slab, it will be necessary to cut back part of the structure before reconstruction can be started.

The appearance of the steel indicated that the concrete had developed but little bond, as the bars were stripped clean and bright, just as in another winter failure that has been reported in the past.

Suggested Precautions

This unfortunate occurrence points out the wisdom of investing in plenty of tarpaulins, salamanders, and coke, and leaving the forms in place until the structure has manifestly gained the requisite strength. It would be the best practice, in order that future failures of this type be avoided, that test cylinders be cast at the time of pouring each floor, that these cylinders be stored on the job under job conditions, and that these cylinders be tested for strength before any forms be removed. This is a safeguard that will automatically prevent the removal of supports before setting has progressed to the desired point.

It is not the direct financial loss to the builder that is so important in these cases, but it is the great loss to the industry when a job of this nature gives the entire field of concrete construction a black eye that is not really deserved.

A little care and forethought, and a little extra expense for winter protection will result in work that is on a par

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Virgil G. Marani, Gypsum Engineer, Dies Suddenly

The sudden death of Virgil G. Marani, since 1918 Chief Engineer of the Gypsum Industries and former building commissioner of Cleveland, Ohio, took place on Monday, November 2, at Evanston, Ill.

Although but 56 years old and apparently in the best of health, Mr. Marani was stricken by brain hemorrhage at his home Sunday afternoon and passed away within a few hours. Services were held at the home, November 3, and interment was at Cleveland the following day.

Virgil G. Marani, for many years Chief Engineer of the Gypsum Industries, Chicago, was born July 4, 1868, at Reggio, in the Province of Emilia, Italy.

Serving as a private consultant and also under the name of "Marani and Moore," Mr. Marani designed and erected all types of buildings, from residences to manufacturing, office and similar buildings. He was Engineering Superintendent of the Cuyahoga County Court House, a $5,000,000 monumental structure and following completion of this building was appointed Building Commissioner of Cleveland, Ohio. After serving as Consulting Engineer for the National Fireproofing Company of Pittsburgh, Mr. Marani became consulting engineer for the United States Gypsum Company, leaving this company to take up service during the war as representative of the War Service Committee on Gypsum.

Memberships were held by Mr. Marani in the American Society of Civil Engineers, the American Society for Testing Materials, the American Association of Engineers, Western Society of Engineers, Cleveland Engineering Society, the National Fire Protection Association, and the Masonic Lodge.

Making Centrifugal Pipe

The Hume Process, Developed for Use in Foreign Lands, Notably in Australia and South Africa, Is Herein Described. Hume Pipe May Now Be Available in This Country, as the Process Is Just Being Introduced. Another Way to Do a Job That Is a Familiar One

Hume pipe is the product of a machine for the centrifugal manufacture of concrete articles, invented by Hume Brothers, Melbourne, Australia, and now made available for use in the United States by the American Hume Concrete Pipe Company, United Savings Bank building, Detroit, Mich.

The process of making this pipe and collars consists of first winding the wire reinforcement on a drum, the longitudinal wires and spiral wires being locked. The reinforcement, varying in weight and strength according to the pressure or external load the pipe is designed to carry, is placed in a steel mold. At the end of the mold, flanges are fixed to a depth equal to the thickness of the wall of the pipe desired. The mold is then laid horizontally in a machine consisting of friction rollers which set the mold revolving. While the mold is turning at a low speed, the amount of concrete necessary for the size of pipe required is inserted, spreading itself evenly over the inner surface and completely embedding the reinforcement. The speed is then increased. At the end of about three minutes the mold is brought to rest, and the water, which, by the action of centrifugal force, has been expelled by the concrete, is allowed to run off. The machine is then restarted and the pipe once more spun about two minutes. During this final process the inside of the pipe is burnished by passing a steel bar over the surface. The mold containing the pipe is now taken from the machine and steamed for four or five hours at a temperature of approximately 100 degrees Fahrenheit. The mold is then removed and the pipe allowed to stand in the open or in water until it is required.

Speed in Manufacture

The length of time required for making the pipe varies according to the diameter. Two pipes 36 inches in diameter and 8 feet long require about 10 minutes, while pipes of the same length but 4 inches in diameter are turned out at the rate of one every minute, six being made on one machine.

Pipes designed to withstand internal pressures are molded with a groove sunk in the end of the wall. When the pipes are butted, these grooves form what may be described as a diamond-shaped canopy or canal. The collars, usually 6 inches in width, overlap these butted ends, 3 inches each way. Before joining is begun in the trench in which the pipe is to be laid, a collar is fixed to one end of each pipe by ramming semi-dry cement and sand between the inside of the collar and the outside of the pipe. This rammed portion occupies just one-half the depth of the collar. The pipe is then lowered into the trench, and the groove at the end farthest from the collar is filled with a plastic material and the pipe squeezed by means of a jacking process into the collar of the last one laid. All surplus plastic oozes out and a compact mass is left in the hollow provided for it. When the surplus plastic has been removed from the inside and the outside of the pipe, the second half of the collar is fixed into the next pipe in the same way; that is, by ramming in more semi-dry cement and sand. This completes the joining. The whole arrangement constitutes a joint capable of taking up expansion and contraction in the pipe. The collar being roughened internally, the cement packing adheres to it rather than to the smooth exterior of the pipe. Thus, the collar and the packing form one sheath within which the pipe can slide if expansion or contraction should cause any movement. If the pipes, therefore, should contract and draw apart, the plastic in the canal, while adhering to the pipe end, would present a concave face to the water under pressure, while expansion would merely close the pipe again. The plastic cannot be expelled, diminished or shifted. If the pipe line is buried under ground where a more or less even temperature is assured and expansion and contraction are negligible, this plastic joint is almost superfluous precaution.

The pipe is made up from 4 inches internal diameter, suitable for telephone conduits, drainage, etc., to 8 feet in diameter, for culverts, well linings, and such purposes, and is made with an aggregate of two parts stone, two parts sand, and one part cement, modification being made to meet extra-heavy external pressure if required.

Good for Other Products

The Hume process is not confined to the manufacture of pipe alone, but may be used for manufacturing from cement any cylindrical object; for example, septic tanks of any size up to 150 persons capacity; fence posts either straight or tapered in any size and length and strength required; columns for reinforced concrete buildings in any size, strength or length up to 12 feet; porch columns either straight or tapered in any size or strength and design to meet the architecture of the building; collars of any size or length in which to set telegraph, telephone, or electric light poles to overcome deterioration from water. Steel pipe either new or used can be lined by the Hume process with concrete of any thickness desired, therefore giving additional strength and a glass-like interior surface, thus doing away with nodules and corrosion.

There are now more than 50 Hume pipe companies licensed and in successful operation throughout the world. They have made and laid millions of feet of Hume pipe from 4 inches to 8 feet in diameter for water-mains, culverts, drainage, irrigation and other purposes.

The National Administrative Council of Uruguay approved on July 10, 1925, a bill for presentation to the Chambers providing for the construction of an Immigrants' Hotel at Montevideo, the building at present used for that purpose being very inadequate, according to Acting Commercial Attache L. B. Clark, Montevideo. The cost is estimated at 150,000 pesos.

New Books

"Reinforced Concrete in Practice," by A. Alban H. Scott, second revised edition. Published by Scott, Greenswood & Son, 8 Broadway, Ludgate, London, E. C. 4, England. Distributed in the United States by D. Van Nostrand Company, 8 Warren Street, New York City.

This is a new and revised edition, known as Volume XVI of The Broadway Engineering Handbooks, published by that concern. The keynote of the volume is better construction by educating the man on the job. The first part contains some good ideas for passing along the necessary knowledge to the workmen in an understandable manner. The book then takes up the matter of specification of materials, choice of form lumber, design and erection of forms, placing of reinforcing steel, and other subjects applying to concrete construction, and illustrates every point in an easily comprehended manner. The author is an authority on concrete construction, and his work is well worth attention.

"Practical Accounting for General Contractors," New Second Edition, by H. D. Grant. Published by McGraw Hill Book Company, Inc., 370 Seventh Avenue, New York City, 323 pages, bound in cloth.

This is a new edition of the book by this author that created so much favorable comment a short time ago. While the first edition was devoted to accounting for the larger contracting organizations, this second edition, just off the press, is devoted to the problems of the average organization. It is written by a man who has had years of experience in accounting work, particularly with contracting organizations, and who is now on the staff of a well known accounting firm in the east. The author enters into the work in a thorough way, and his book is well worth study.

Trade Publications

Such factors as granite facing and waterproofing of concrete block are discussed in a good printer's job published by the C. E. Lindsley Company, Irvington, New Jersey. Some interesting facts about the manufacture, handling and waterproofing are made more interesting as illustrated with a half-dozen photographs of the men at work in the plant and the finished product.

The October, 1925, issue of *The Journal of the Boston Society of Civil Engineers*, just received at this office, features the fresh water supply for the Somerset station of the Montaup Electric Company, Massachusetts. This journal contains as well papers on "The Development of the Science of Hydraulics," by Edward P. Hamilton, "Protecting the City Plant," and "New Theories of Flow in Pipes," and may be secured upon application to the Society at 715 Tremont Temple, Boston.

"The Principal Lumber Industries," featuring lumber and timber products, is a recent product of the government printing office. Contents of the booklet are chiefly statistics.

Questions that arise in the process of securing a patent are answered in a fifty-six page booklet issued by Richards & Geier, patent trade mark attorneys, 277 Broadway, New York. This firm has also just published the fourth edition of *"Trade Marks, Trade Names, Unfair Competition."* Both may be secured gratis upon application.

A. S. T. M. Tentative Standards, 1925, have just been published by American Society for Testing Materials, and may be secured, upon receipt of the selling price, from the Society, at 1315 Spruce Street, Philadelphia. The current volume of tentative standards comprises 876 pages, and contains 194 tentative standards. These include ferrous metals, non-ferrous metals, cement, lime, gypsum, clay products, preservative coatings, petroleum products, road materials, coal and coke, timber, waterproofing, insulating materials, shipping containers, rubber products, textiles, slate, and other materials. These tentative standards are published for the purpose of eliciting criticism and suggestions from the field, and when finally revised and approved, will be made "standard" at some later meeting of the Society. Some of them may be dropped in favor of better tentative standards should experience so dictate. Purchase of this volume is suggested for the purpose of comparing these tentative standards with the experience of the reader.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit. Convention, Feb. 23-26, 1926, Hotel Sherman, Chicago, Ill.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago. Convention, Feb. 22-23, 1926, Hotel Sherman, Chicago, Ill.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 West Thirty-ninth St., New York City. Annual meeting, for members only, December 10, 1925.

American Road Builders' Association; Wm. H. Connell, President, Miss E. A. Birchland, Secretary, 29 W. 39th St., New York City. Annual convention and Good Roads Show, Chicago, Jan. 11-15, 1926. Exhibits.

Associated General Contractors of America; D. H. Sawyer Secretary, 1038 Munsey Bldg., Washington, D. C. Next convention January, 1926, Portland, Oregon.

Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Frank Burton, President, J. F. Downey, City Hall, Cambridge, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, 160 North La Salle St., Chicago. Annual meeting, March, 1926, Atlantic City, N. J. Date not selected. No exhibits.

Concrete Products Association; W. H. Carey, President, Bert Carey, Secretary, 111 W. Washington St., Chicago, Ill. Next convention, Jan. 27, 28, 29, 1926, Hotel Cleveland, Cleveland, Ohio.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

National Association of Building Trades Employers; A. E. Coleman, President, 37th St. & Stewart Ave., Chicago. A. W. Dickson, Executive Secretary, 214 Electric Bldg., Cleveland, Ohio.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 East Fayette St., Baltimore, Md.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.

National Sand and Gravel Association; T. R. Barrows, 903 Munsey Bldg., Washington, D. C., Secretary.

The National Lime Association; Burton A. Ford, Secretary, 918 G. Street, N. W., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington St., Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, 425 E. Water Street, Milwaukee.